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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION

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Lessons from Wasters.

There is one basic difference between normal steel works and iron foundry research, as in the former the receptacle for the material is fairly well standardised, whilst in the iron foundry an enormous number of variables can enter. To be more explicit, the conditions may be that in a steel-ingot shop the composition of the metal, the pouring temperature, the teeming speed, and the most suitable type of ingot have been determined, but in an iron foundry, even though all these have been ascertained and successfully reproduced, there is still no guarantee that a good casting will result. It may, perhaps, be interesting here to point out, for the benefit of steel-metallurgists and the mechanical engineer, the considerable number of causes which may operate to produce a "waster" casting. Primarily, it may be the metal, which can be of unsuitable composition, owing to one of a considerable number of variables being uncontrolled. Additionally, from the foundryman's point of view, it may be too hot, too cold, too hard, too soft, dirty or badly mixed. Apart from questions associated with ingot manufacture, the steel manager's problem is well on the high road to resolution, but the foundryman's has scarcely started, for on seeing a waster leave the mould he cannot at once ascribe it to defective metal, whereas a cracked, piped or blown ingot can immediately be relegated to metal trouble, as nowadays the pouring of the ingots is a fairly definitely established science.

The foundrymen obviously must hesitate in condemning the metal, for of equal importance is the sand employed for the making of the mould and the construction of the mould itself. Of the former, to quote the moulder's terms, the sand may be too wet, too dry, too open, too close, too strong or too weak. Here are factors about which there is only accumulated knowledge available, but no real research. Furthermore, it is one which will retain moulding as an art rather than as a science for many years to come. Perhaps, in the distant future, it may be established that for making a casting of a definite weight and superficial area, the moulder must use a sand of chemical composition lying within a definite specification, and which admits of a definite grain size as measured by some standard means.

Whilst obviously this would be of the greatest utility to moulders, the problems of wasters would not be entirely resolved, for there still remains the construction of the mould, which again, according to the moulder, may be rammed to hard or too soft; the runners may be too large or too small, insufficient in quantity or badly placed; risers, too, are a matter for consideration, for whilst a necessity in some cases, they are sometimes the cause of the very trouble they are supposed to obviate. Other defects which cannot always be ascribed to either sand or metal are scabs (often a blacking trouble), run-outs, poured short, cracks, air locks and cold shuts.

The object of the above is to impress upon critics of faulty iron castings the very formidable list of contributory causes of wasters, but they will perhaps be more lenient in their judgment if they take into consideration the amount of money and work bestowed upon medical research and the birth of defective children, in comparison to the starved foundry and the production of defective castings.

Foundry work still remains an art, and until research, both practical and theoretical, has converted it into a science, then just so long will wasters continue to be made.

To the foundryman we would say, do not hide your wasters, for it is only by their close investigation can their repetition be avoided. Whilst they are never a thing of which to be proud, nevertheless, owing to the immense number of variables present, they are seldom an object *pour rire*. The too-quick dismissal of wasters is largely due to the fact that so few records are kept in many foundries associated with an absence of standard practice, so that on the birth of a waster it is impossible to ascertain from what direction the cause comes. *There has been no deviation from standard practice, because no standard practice exists.* A consultant can be of little help in the resolution of the waster problem until he can be given a true picture of standard practice.

Casting Golf Clubs.

Mr. Morris A. Hall, writing in "The Iron Age" under the title of "Side Line Tides Foundry Over Depression," gives some interesting details of the casting of golf club heads.

The foundry of the Monel Metal Products Corporation, Bayonne, N.J., a subsidiary of the International Nickel Company, seeing new fields for the metal and more work, golf club heads were tackled several years ago. It is a well-known fact that the advanced golfer is very particular about his clubs, especially his irons. In caring for these, however, it is found that they rust easily. This is probably due to the fact that, in use on the links, they become wet or damp, with no means of drying them until the club house is reached an hour or two later. When the iron has rusted it can be cleaned up only by buffing, or grinding and buffing, according to how badly it has rusted. This process changes the size and shape, and with it the hang of the club, for no matter how minute the amount of metal taken off, several repetitions of this treatment make an appreciable difference.

Monel metal is both rust- and acid-proof, consequently it fits well into this service. Moreover, it has a nice white colour, not unlike silver, which gives it a good appearance. As it is hard, like steel, it wears well: as it is strong, it will withstand the hard knocks equally as well as steel heads. In addition, it is slightly more resilient than steel, so that the ball will leave a monel metal head "clean," and with just the right "feel."

If desired it can be given a very high polish, and when polished it will retain this beautiful surface sheen much longer than other metals. When given its normal dull finish, after some use it can quickly be restored by the use of soap and water, or by rubbing with sand.

The fact that it is a cast metal, and when cast has the properties of forged steel, makes it possible to duplicate any head or to copy the best imported forged heads from the leading Scotch cleek makers, without variation, quickly and, comparatively speaking, cheaply. Granting all these qualities, it was simply a matter of getting golfers to try the new metal, when it was at once established as satisfactory.

Some 35,000 of these heads were turned out in 1921, up to the middle of September. For 1922 the company expects to turn out about 60,000.

This could hardly be classified as "tonnage," for the heads average 0.6 lb. each. A gate of six of them, with very large risers and wide gates, total less than 10 lb.

It has been found that this metal gives the best results only with baked moulds, as well as baked cores; but in very small articles, weighing a pound or less, such as these golf heads, the moulds are made in green sand.

While cast as a gate, these patterns are individually not gated, so that it is possible to change the shapes very quickly. A new pattern is simply substituted for the one which is least wanted, and the moulding goes on exactly as before. In moulding the metal, very wide gates and many large risers must be used, because the metal is not easily held in a fluid state. It has to be heated to 1,150 deg. C. in melting, but does not hold this high temperature for any length of time, and must be poured quickly. Hence the moulds are made up with wide gates and easy bends, so as to lead the metal to the moulds quickly, while still hot.

The metal is poured from ladles holding 100 to 150 lb., after pouring and deoxidising with magnesium, using 1½ oz. per 100 lb. This is a continuous process, as many moulds being poured each heat as are ready for pouring, and the moulding going on continuously. They are bench moulded, and are rammed up by hand.

After casting, the excess metal of gates and risers is cut off, and is cleaned before being charged back into the furnaces. An average furnace charge is 40 per cent. scrap and 60 per cent. new metal. The cutting off is done with a very fine alundum wheel, but large risers are burnt off with the oxy-acetylene torch. Afterwards the individual castings are ground to a clean, smooth surface.

This is rather a nice job, because the shape as cast closely approximates the shape desired, and only enough metal should be taken off to produce a smooth, even surface. Special holding fixtures are not used, since this would run the expense up too high, but these are approximated by holding the heads in formed soft pine blocks, and grinding them while so held. These blocks are 4 × 3 × 1¾ in., this being large enough, on the one hand, to receive the golf head, and a good size for the workman, on the other.

The head is slipped into a block and held up to the grinding wheel and the grinding completed as quickly as possible. But this is not an instantaneous process as one might think, for the surface is quite hard, and a number of applications are necessary. A large and wide wheel is used, this being a Norton alundum, 14 × 2½ in., grain 29, grade 2. The operator soon acquires great skill in producing the required smooth surface without taking off much metal, and this, in turn, becomes a factor in turning the heads out quickly and cheaply.

After the grinding is completed, the socket for the handle, which has been cored out slightly, is reamed. For this purpose a special taper reamer is used and the heads, which usually have a very mean shape with nasty angles, are held in a special vice with hinged jaws, a drill press being used. The heads are slid into the vice from below, a turn of the handle catches them, the drill press arm is drawn down, moving the reamer into the cored hole. A little more pressure, and in a second the socket is complete. In this form, the golf heads are completed so far as this plant is concerned. A good tip for foundrymen, taken from this instance, would be: "in dull years get into some form of sporting goods production."

Correspondence.

[*We accept no responsibility for the statements made or the opinions expressed by our correspondents.*]

Iron Foundry Cupola Management.

To the Editor of The Foundry Trade Journal.

Sir,—I shall be quite willing to pay for the entire cost of melting if Mr. McClelland can demonstrate that he can melt 15 tons of suitable iron at a ratio of 1 in 20 as stated, the whole to be under normal foundry conditions, viz., the charges to consist of about ¼ pig, ¼ medium heavy scrap (pieces not to exceed 84 lbs. or 2 in. in thickness), ¼ return gits scrap. The class of castings also to be such as are found in an ordinary foundry, say, ⅓ cored work, such as pipes, etc., ⅓ machine castings, ⅓ rough castings. The quality of the casting to be such as ordinary customers would receive.

I think it will be admitted the above are about the average a foundry foreman has to meet.

It is not economy to melt metal that will not run the work, or employ labour at 12s. per day to reduce the scrap in order to save 3s. worth of coke. We all cannot use stove grate scrap and rainwater goods, even if there was enough to go round. I have no objection to Mr. McClelland using as many tuyeres as he wishes, but do not want the old game of using the top tuyeres simply to increase the depth of bed, closing these after a time, and so artificially lowering the melting zone. In this case the extra bed between the two rows of tuyeres is to be counted in the actual coke consumption.

I notice in the previous experiment the bed charge was just twice the weight of all the coke used in the charges.

If Mr. McClelland accepts these conditions I have no doubt Mr. F. J. Cook and Mr. Bartlett will act as arbitrators.—Yours, etc., J. Shaw.

39, Montgomery Road, Sheffield.
April 15, 1922.

Works' Magazines.—It is estimated that there are now more than 200 firms publishing their own magazines in this country, and in the offices of the Industrial Welfare Society complete files of some 150 of these "firms' newspapers" are displayed. They include engineering firms of all kinds, iron and steel manufacturers, shipbuilders, collieries, etc. With the object that the editors of these magazines shall pool their experience and solve their common difficulties, the Industrial Welfare Society is now arranging the second of a series of annual conferences, to be held in the Society's offices at 51, Palace Street, Westminster, on Friday, April 28.

The Manufacture of a Monobloc Motor Cylinder Casting.

By W T. Evans.

Continued from page 268.

The only operation in ramming, finishing and stoveing the mould which requires much explanation is that the middle part has a tendency to drop out if not properly handled. The practice is to ram up the required number of bottoms or drags, finish and black them, then proceed to ram

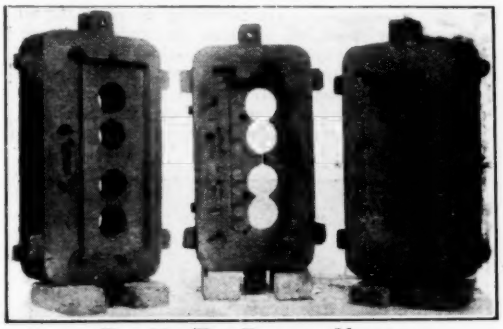


Fig. 11.—The Finished Moulds.

the middle parts. When this part is taken from the machine the drags are close at hand, and the middle part is placed on its corresponding drag part and is then finished and blacked whilst in this position. These two parts of the mould are then stoved and dried together. This prevents the middle part from dropping out when green. The moulds are taken apart when dry, and blown out before casting.

Fig. 11 shows the three parts of the mould, and illustrates that there is nothing to carry the overhanging sand of the middle part other than the bars or grids, so in some cases planed plates are used for the purpose of drying this part, but this is not necessary if care is used.

The cope is a very plain piece of the mould, and requires but little finishing. The runner is seen on the outside. This matches with the spray shown in the flange core-box, and is clearly shown in the view of the mould cored up ready for the cope. This part can be used green if there is not ample stove room.

Numerous methods of running this casting have been tried, but the method here shown gives the best results; that is, a number of small sprays running directly into the barrels, with two risers one at either end of the flange. It is not insisted that this is an ideal method, and no doubt other ways of pouring this job would give good results.

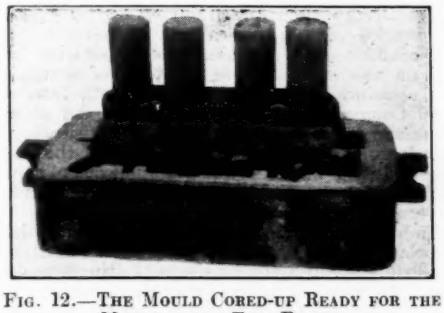


Fig. 12.—The Mould Cored-up Ready for the Middle and Top Parts.

Some foundrymen may object to the flange of this casting being made with a core, but it will be evident that when the middle part is rammed up it has only to be stricked off to the planed joint of the box, whereas if the flange had to be moulded in this part the box would have to be made the correct depth of the flange of the cylinder, and therefore only suitable for one depth of casting. Further, with machine moulding, this flange would have to be bedded in whilst on the machine—the machine would be standing, and valuable time lost, whereas when a core is used the moulding is a simple job, and the machine can be operated to the extent of its output.

The pouring of this casting in a vertical position is, in the author's opinion, a much better and safer method than that of casting in an horizontal position. There are several reasons for this; first, that whilst cylinders can be made successfully horizontally, the author is in favour of pouring vertically where possible, as there is not the tendency for small pieces of foreign matter to lodge underneath the barrel cores, and as the bores must be perfect the less risk taken the better. Secondly, when moulded vertically, the coring of the mould is a very simple job, and the use of chaplets is almost eliminated in this particular casting, only two being used to hold the loose piece of the jacket core. When this casting is made jointed the opposite way, the jacket cores have to be carried on chaplets, and this is not satisfactory. Also all the cores are more difficult to make and fix in the mould.

When the mould is ready to receive the round barrel cores, before placing these cores in position two plain, round wooden plugs are pushed through the middle part of the moulds and in the jacket cores. This ensures the outside of the cylinder barrels being in alignment with the jacket cores, and as very often the casting is jigged from the outside of the barrels, it is essential that the castings are true in this respect.

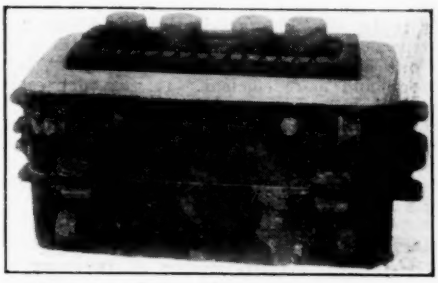


Fig. 13.—The Mould, less the Cope.

Fig. 12 shows the mould cored up ready for the middle part and cope to be put on, and is self-explanatory, and Fig. 13 is a view of the mould less the cope, and shows the sprays in the core, the method of fixing the core, which is simply placed on the middle part, and registered with the cylinder barrels, no further prints being necessary.

Provided the job is carefully cored up, with attention given to the vents, clean moulds laid down, and cast as hot as possible, good results should be obtained.

As mentioned above, there have been shown in the technical foundry papers the methods used in casting this particular job horizontally, and it is hoped that this Paper will show foundrymen the opposite methods used, with the result that they will be able to adopt whichever method they think will be of more service to them.

The chief points are: (1) By constructing the pattern as shown different depths or lengths of cylinders can be used in the same moulding boxes; (2) by making the flange with a core, the machine moulding is a simple job; (3) casting vertically is much better than horizontally; (4) the coreing of the mould is simple and safe, few chaplets being necessary; (5) the ease with which the cores can be made. All of these are in favour of the foundryman in his endeavours to produce this casting in the quantities asked for.

With reference to the iron used, these castings can be made successfully by the use of ordinary cylinder mixtures, or the so-called semi-steel mixture, with 15 to 20 per cent. mild steel, and a suitable analysis is Si 1.8 – 2.25, S 0.08, Mn 0.6 – 0.8, 0.80 to 0.90, the carbon being slightly

different if using iron without the addition of steel, the latter nearly always being lower in total carbon.

Owing to the low silicon content of the iron used, it is advisable to use dry sand moulds for this class of casting, as there are very thin sections in the water jacket, very often only 4 mm. thick. The tendency to get chill in this part of the casting is not so likely if cast hot in dried moulds.

DISCUSSION.

Mr. H. Moore, immediate Past Branch-President, said he hoped the lecture would be fully recorded in the Journal, for one result would be that they would be looked upon very favourably by other branches and would show of what the East Midlands was capable. They had as a President a thoroughly practical man, who also knew his theory, and he was happy in complimenting Mr. Evans on the advanced work which was being carried on in his foundry.

Mr. Stevenson, seconding, said Mr. Evans had shown himself an expert on oil-sand cores. It was remarkable that though oil-sand cores had been in existence 25 to 30 years, how few foundries availed themselves of the innovation. A mono-bloc casting could not possibly have been made without oil-sand cores. He had been using oil-sand for some three years, and it had become so much in favour in the works that ordinary sand had been practically eliminated altogether. If a large core had to be made the core-box was lined with an inch or two of oil-sand, and the centre was filled in with floor sand. Sometimes, when the core became too hot, the whole of the centre tumbled out, leaving the complete shell sometimes only half an inch in thickness, which can simply be filled up again with floor sand and cast without any trouble whatever.

Mr. A. S. Clarke (Loughborough) pointed out that the absence of technicalities had enabled them to follow the making of these intricate cores.

In reply, Mr. Evans said there had been a lot of experimenting at his works with mixtures, and the one he gave was the best for results, being cheaper and more efficient. It was very seldom they had blown cores. If any members wanted further information he would be happy to help them. Their foundry was quite open for inspection, and they had no secrets to keep. It was generally accepted in foundries that the vertical way was the one which gave the best results.

Porous Aluminium Castings.

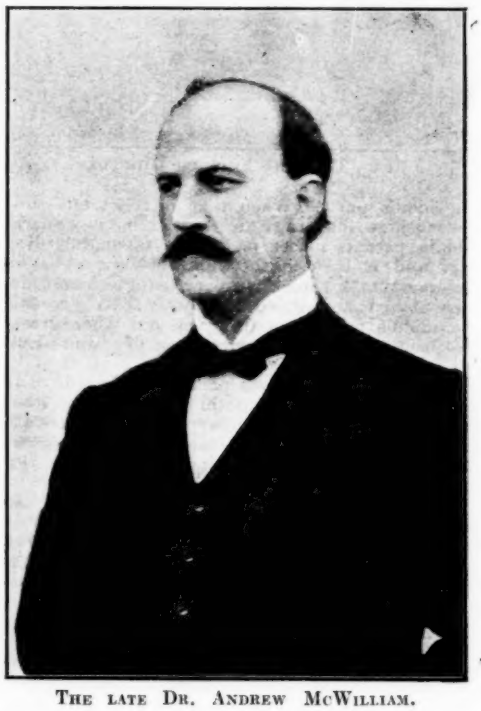
Mr. Douglas P. Muirhead, writing in "Machinery," states that considerable difficulty is sometimes experienced in obtaining aluminium sand castings which will not sweat under water test; therefore the treatment used to make such castings sound and able to stand a hydraulic test of 20 to 30 lbs. per sq. in., without any signs of sweating, is of considerable interest. The castings which gave the writer most trouble, due to sweating on water test, were a sand-cast aluminium petrol cock body, and a water pipe of the same material, with four branch outlets for a motor engine; both castings required to be hydraulic tested to 10 lbs. per sq. in.

Having heard that water glass (sodium silicate) had been successfully used for porous castings; some rejected castings were treated with very good results. A solution was made up of one part of ordinary water glass to two parts of water, and the solution was used hot and under pressure inside the castings. The pressure was kept on the casting for a short time after sweating ceased, and the casting was then washed out with water, and tested under hydraulic pressure if necessary. The last-mentioned test is not necessary, as the solution can be kept at the required test pressure in the casting. Small castings have also been successfully treated for porosity by thoroughly soaking in a pail of the hot solution. The solution can evidently be used for long periods without affecting its action.

The Carron Company having closed down their showroom at Birmingham, Mr. C. J. Evans, formerly manager thereof, has been appointed Midlands representative of Samuel Smith & Sons, Limited, Beehive Foundry, Smethwick.

The late Dr. Andrew McWilliam.

The death took place on April 7, at Sheffield, of Doctor Andrew McWilliam, a metallurgist of world-wide fame. Receiving his early education in Glasgow, where he was born, he went to the Royal School of Mines, London, where he obtained a first-class Associateship in Metallurgy, and a Royal Scholarship for the best aggregate marks for two years, the highest honour of the course. He joined the staff of the Sheffield Technical School in 1887, and was later appointed chemist and steel manager to the Martino Steel Company, Sheffield. Leaving this, he became lecturer in metallurgy to the Staffordshire County Council, and was later appointed manager of the danger area of the British Explosives Syndicate. He returned to Sheffield to take up the post of lecturer in metallurgy at Sheffield University, where he worked in close co-operation with Dr. Arnold. He was subsequently appointed assistant professor, in which capacity he did great service in connection with Sheffield high-speed steel, particularly in the defence of it in a great law suit in America. In 1911 he was



The late Dr. Andrew McWilliam.

appointed Chief Metallurgical and Analytical Inspector of Steel for India by the Government of India, and shortly after his departure the University of Sheffield conferred the degree of Doctor of Metallurgy upon him. During his six years in the service of the Government of India he won the confidence of all those associated with him, and on the expiration of his term of service he was appointed metallurgist of the Tata Iron and Steel Company of India. In 1919 he was made a Commander of the Order of the British Empire for pioneer work in the establishment of the heavy steel industry in India and its application to war work, which was also recognised by the Indian Government.

On his return from India, Dr. McWilliam quickly associated himself again with the steel industry of Sheffield. He practised as a consulting metallurgist, his services being in great demand. As President of the Sheffield Society of Engineers and Metallurgists from June, 1921, to the brief illness which preceded his death, he was actively engaged in imparting his knowledge to the members of that body.

Dr. McWilliam was a versatile and active contributor to foundry technology and steel metallurgy, and in a list of 32 papers and researches he covered such items as "Thermal Transformations of Carbon Steels," "The Elimination of Silicon in the Acid Open-hearth," and in conjunction with Dr. Longmuir, published a book on "General Foundry Practice," the third edition of which has recently been published.

XUM

Non-Ferrous Electric Furnaces.

Mr. F. Kilburn and Mr. H. C. Dews, of Huddersfield, combined to give a paper on "The Manufacture of Non-Ferrous Alloys in the Electric Furnace" at a meeting of the West Yorkshire Metallurgical Society, held at the Leeds City Museum Library on April 1.

Those who follow the literature of this subject (said the authors) will perhaps have noticed that writers frequently endeavour either to advertise a furnace, to explain a mechanical device, or to emphasise an electrical condition. Very seldom is the metallurgical aspect of the question adequately noticed. In this paper the authors do not intend to describe in detail any particular furnace, nor do they intend to advance arguments in favour of universal electric melting.

Non-ferrous alloys in general commercial use may be divided into three classes, according to their casting temperatures.

(a) Alloys having a low casting temperature, such as white-metal alloys, solders, pewter, Britannia metal, and light aluminium alloys.

(b) Alloys of the largest industrial use, such as brass, bronze and German silver.

(c) Alloys with a high casting temperature, such as cupro-nickel, nickel-chrome, and manganese alloys. Like all arbitrary classifications of natural phenomena, this sub-division cannot be rigidly maintained, yet its applicability is reasonably plausible, and for the present purpose its great convenience will be subsequently demonstrated.

Low Melting Point Alloys.

The first class of alloys to be considered will be that in which are those alloys cast below 800 deg. C., or thereabouts, such as white metals, Britannia metal, pewter, soft solder and light aluminium alloys. These alloys are capable of sub-division into two series—the lead-tin series and the aluminium.

To consider the lead-tin series first it is apparent that at the low temperatures used, oxidation, volatilisation, and similar sources of loss are comparatively unimportant, and are practically eliminated by the use of a suitable slag covering. Indeed, the manufacture of these alloys is usually a simple matter of mixing and melting. Lead antimony and similar alloys will cause more difficulty in mixing than melting, as those containing a high content of lead invariably show a segregation of the metal to the bottom of the crucible and the casting. Overheating should be carefully avoided.

Probably the only type of electric furnace which can be used economically in making white-metal alloys will be that where the heat is generated in an external resistance, such as wire or ribbon winding. When this principle is used the rate of heating and the ultimate temperature attained are under almost perfect control. The furnace can be used intermittently without undue loss, and can be constructed to operate with large or small crucibles or pots of almost any shape. For small charges the furnace may be portable and may be worked off any industrial current supply mains. As the maximum temperature it is possible to attain is usually under 1,000 deg. C., depending on the alloy used for the resistance winding, this method of heating cannot, of course, be used for alloys other than those in this group. It is unfortunate that this otherwise satisfactory furnace has no automatic mixing device. An induction furnace which would satisfy this condition is unsuitable in its present industrial form owing to the failure of the refractory lining through being attacked by lead.

The light aluminium alloys with small amounts of magnesium, zinc and copper, to be here considered, require more care during their manufacture than the alloys in the previous series. As will be shown later, a comparatively high temperature is required to fuse aluminium, and disadvantage of this property of the metal is accentuated by its low specific gravity. Aluminium and the other constituent metals of these alloys all very readily oxidise and the effect of overheating is injurious and wasteful.

Chiefly owing to difficulties in construction, indirect resistance furnaces are unsuitable for bulky aluminium alloys. Where the power is available the high frequency induction type would possibly be used satisfactorily and would efficiently avoid the danger of overheating. The furnace can be worked entirely closed so that oxidation would be minimised and the charge would be well mixed. This type of furnace is yet insufficiently developed, but as its capabilities are better appreciated and receive the attention of the electrical and mechanical engineer, it will perhaps provide the solution of the problem of aluminium alloy-making in an electric furnace.

When any non-ferrous alloy is to be made in the electric furnace the nature of the refractory material used for the container for the molten metal should have serious consideration, and in this metallurgical survey a few remarks on this subject should not be out of place. The number of available refractory materials is small, and of those commercially available magnesite is the only one that can be used for lead or aluminium alloys. Magnesite, as is well known, has many disadvantages, and cannot be used for narrow channels and intricate parts of induction furnaces. Asbestos cement, which is often used for these parts, is rapidly attacked by lead. Thus the position here, as in many metallurgical operations, is such that there is a very urgent need for a suitable refractory material.

Medium Melting Point Alloys.

In the second class of alloys will be included those whose casting temperatures fall between 800 deg. C. to 1,300 deg. C. Satisfying this condition the copper alloys common in engineering immediately assert themselves in one's mind, and this section will deal mainly with brass, bronze, and nickel silver. It will be noticed that zinc is a constituent of most of these alloys, and its loss in foundry practice is well known, but certain details affecting this loss are worthy of recapitulation. Zinc is lost in fuel furnace practice entirely by either oxidation or volatilisation, therefore by eliminating air from the vicinity of the charge this loss would not be entirely avoided, as zinc is volatile above 930 deg. C., and, furthermore, its vapour reduces carbon dioxide at these elevated temperatures with the production of zinc oxide and carbon monoxide. This strong affinity for oxygen is responsible for the reduction by zinc of dissolved and intermixed oxides of the copper, tin, nickel series.

The absorbing properties exerted by copper towards the gaseous products of combustion, such as carbon monoxide, sulphur-dioxide, etc., in fuel furnaces, should be nullified in an ideal furnace, Oxygen is usually eliminated from copper by the addition of an alloy or metal for this purpose, such as phosphor-copper, phosphor-tin, silicon-copper, etc., but this procedure is often expensive and inefficient. Some gases absorbed by molten copper are not removed until the metal is cast and some remain in solidified metal with deleterious effects.

The oxides of tin in bronzes are removed by the above additions, but the amount of these oxides should be greatly reduced by the use of electric furnaces.

None of the alloys now under consideration dissolve or combine with carbon, except perhaps good quality nickel silver, on which the effect of carbon is very slight.

The usual procedure in making these alloys is to add the tin, zinc, etc., to molten copper. This is effected by first melting the copper and heating to something like 1,300 deg. C., and making the addition in the furnace before pouring. The specific heats of tin and zinc are below that of molten copper, and the melting point of the alloys falls with increase of tin and zinc so that when a moderate addition of the last two metals is made the absorbed heat contained in the copper when melted is sufficient to keep the alloy fluid for casting purposes. It is thus seen that the ideal furnace for these alloys will be one which will attain a temperature up to 1,300 deg. C., without any local overheating. Oxygen must be rigorously avoided and a reducing atmosphere retained in the furnace. The direct arc type will be entirely unsuitable. Experiments with this type of furnace undertaken by the United States Bureau of Mines in melting yellow brass showed a metal loss equal to 7.5 per cent. Furthermore, volatilised zinc interferes with the efficient working of the furnace

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arc, and it is said by Hansen that copper when melted alone is volatilised producing a very poisonous vapour. The indirect arc type is sometimes usefully employed for brass melting when the furnace may be rotated.

The Detroit Rocking Furnace, which is of the above type, melts 2,000 lbs. charge per hour, with a loss of 1 per cent. metal which appears to be the result obtained during the best possible working conditions. This type of furnace, however, is more generally suitable for bronze or gun-metal.

The horizontal ring induction furnace is unsuitable for brass alloys as their high conductivity causes trouble due to the "Pinch" effect. The vertical ring induction furnace is, however, a nearer approach to the ideal when it can be used continuously for the same alloy.

The Ajax-Wyatt furnace is probably the most widely known and used of this class of furnace. The furnace provides a thorough mixing of the charge, very uniform heating, and no local overheating.

The running costs are low, due partly to the elimination of the constant waste of electrodes; a steady power load obtained, and the thermal efficiency is high. As used by the Bridgeport Brass Company, U.S.A., the zinc loss is under ½ per cent. when melting brass.

Where continuous working with one class of alloy is not possible it will be cheaper and more convenient to use an indirect resistance type of furnace such as the "Bailey." This provides the necessary condition for successful brass, making with a loss of metal of about 1 per cent. This furnace may also be used for bronze, gun-metal, and similar alloys, although its thermal efficiency is not so high it is remarkably efficient metallurgically.

Crucible furnaces heated by a carbon resister have been designed by Drs. Greenwood and Hutton and by Dr. Thompson, and have been applied successfully to melting nickel-silver scrap, whereby the concentration of impurities, the increased carburisation, and the continued loss of zinc, which occurs by continuous remelting in fuel furnace, is said to be entirely avoided.

High Melting Point Alloys.

The third and last class of alloys is that containing those cast at a temperature over 1,300 deg. C. Such alloys are cupro-nickel, nickel-chromium and manganese alloys and those containing tungsten, molybdenum, cobalt, silicon, and similar refractory elements.

Probably the most important property to consider before making these alloys is their relationship towards carbon. Most of them will absorb carbon when molten, and on cooling they retain this element either as a free carbide or as graphite originating in the decomposition of carbides. The effect of this carbon on the properties of the alloys is generally considerable and always greater than its effects on the lower temperature alloys just considered. These factors render it unfortunate, from a metallurgical point of view, that the only thermally and financially satisfactory furnace to use for the manufacture of these alloys is one of the type employing a direct carbon arc. An exception to this generality is found in the fact that at least one American firm are making the alloy nichrome in an horizontal ring induction furnace. That this is an exception, however, is proved by the study of a few actual examples of present-day practice. Cobalt-chromium alloys are being made in a Snyder furnace. The United States Mint use the Rennerfelt furnace for making nickel coinage alloys. Monel metal is melted by means of the Von Schlegell repelling arc. The reducing atmosphere in these furnaces is a factor contributing to this increasing popularity, but the preparation of carbon-free high-temperature alloys in the electric furnace is still a problem urgently requiring solution on a commercial basis.

It is a subject for continual lament that the refractory material used for the lining of the furnace is often a source of weakness in high temperatures work, and in making any of the alloys in the class just considered, a modern, and at present expensive, refractory must be used. Under moderate temperature all the usual commercial refractories, such as bauxite, magnesite, fireclay, and silica will fail by disintegrating and softening about 1,600 deg. C. Alundum and carborundum may be used successfully for high temperatures and pressures, but the possibility of carbon contamination of the alloy must not be overlooked.

In conclusion it should be emphasised that many and varied as are the kinds of electric furnaces suggested and advertised, their possibilities and peculiarities are not so dissimilar and exhaustive as to fulfil all the diverse and complex conditions imposed on the maker of non-ferrous alloys, and the metallurgist who would effect an economy by the use of an electric furnace is confronted by an interesting and complicated problem. Many types of furnaces may be used for a single alloy, and many alloys may be made in any single kind of furnace, but the result will not be always satisfactory.

The choice of an electric furnace which can be used efficiently for a certain alloy or for a particular class of work will be governed by a multitude of factors, and when the ideal furnace has been chosen for the specific use required, then and not till then, should comparisons of cost be drawn between the electric and the fuel furnace.

Formite.

According to a pamphlet received from Messrs. Pinchin, Johnson & Company, Limited, General Buildings, Aldwych, W.C.2, who are the sole selling agents in this country, Formite (a special form of cement for grinding purposes) reduces the cost of grinding rough castings and forgings, facing up flat surfaces, polishing, etc., by more than half when employed on disc grinding machines. Abrasive disc grinders made with Formite cement grind the work faster than a cloth disc, and are claimed to outlast 15 or more cloth discs. Discs coated by the cement have been known to last as long as 40 cloth discs, resulting in the saving of much expensive labour and time employed in dismounting worn cloth discs and mounting new discs. A feature of formite cement discs is that they will grind wet or hot; they will also grind both hot and wet, owing to the waterproof nature of the adhesive.

Steel discs coated with this cement have been used now for six years. The procedure to be followed in employing Formite cement for coating the discs is as follows:—

The temperature of the steel disc is raised to only 20 deg. C. (68 deg. F.), and afterwards given a thick coating of cement over the surface, allowing it to settle evenly over the surface for about three minutes. On to this layer of cement is sprinkled a thick layer of abrasive grains, the size depending on the nature of the particular work to be ground. The grains are rolled in with a hand roller to press them into the layer of cement, and the disc then tilted to allow the surplus grains to fall off. Afterwards it is placed in a gas- or oil-heated stove, and, starting from cold, raised to a temperature of 120 deg. C. (248 deg. F.) at the rate of 10 deg. C. (18 deg. F.) per hour. When the steel disc has attained this temperature the Formite cement has become quite hard (harder than glue) and the abrasive grains are held firmly to the steel disc. The stove may then be turned out and the discs allowed to cool.

Book Review.

Elektromotorische Betriebe. By A. Schwaiger. Berlin: Walter de Gruyter & Company, Genthinerstrasse 38, W.10. (Price 1s. 6d.)

This is another little volume in the Göschen Collection, and deals with the theoretical principles in calculating electric-motor drives. In the first section resistances (friction, gravitation, inertia of mass, and in the case of machine tools, resistance due to cutting, etc.), and the necessary forces to overcome these in continuous, intermittent, and strenuous working are discussed, and the construction and use of the necessary diagrams (those of speed, distance, force, current, and work performed) are explained for calculating the sizes of motors. The second section is devoted to the consideration of working costs, both permanent and variable, of electric-motor driving, and these are briefly compared with those of drives by other prime movers.

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Liquid Fracture in Iron Castings.

By S. G. Smith.

What is meant by liquid fracture in the present case may be explained as follows: It is an occurrence which takes place in a casting before the whole of the casting has become solidified, and is quite distinct from what is commonly known as draws, sponginess, segregations, etc.

The fracture is sometimes so small that it requires a magnifying glass to detect, and occasionally so large that it separates the casting in two pieces. Such fractures may possibly occur in any part of the casting, but the most likely place to find them is in the proximity of a thin and thick section, or near the point when the casting turns abruptly at right angles.

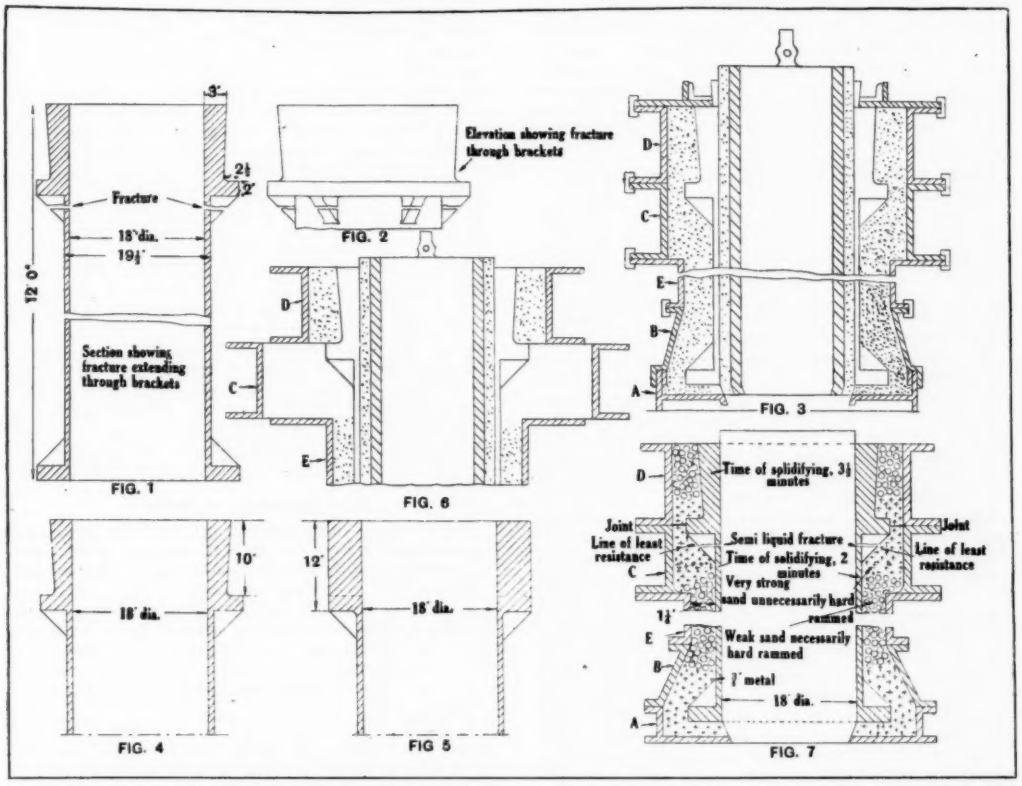
The fracture dealt with in this article occurred in flanged pipes, made vertically, of different lengths and diameters, and of many thicknesses, sometimes with brackets on the flanges, but more often on those castings without brackets. For a long time the liquid fracture appeared whether the pipe was thick or thin, bracketed or otherwise. The writer does not wish to attach in this case any fault to the engineer or draughtsman regarding design, as it will be seen later that design had practically little to do with it.

The foundries where the castings were made were on a large scale, and it became a serious matter to the management, as it was common for 50 per cent. of such work to be wasters. Eventually the supervision of this kind of work was put into the hands of the writer, with a free hand to adopt what measures he thought best to remedy the evil, and the remedy proved to be a work of research.

Figs. 1 and 2 are illustrations of a pipe showing where the liquid fracture occurred. It will be seen that the fracture is immediately below the flange right through the fillet and bracket underneath the flange.

Fig. 3 shows the whole of the boxes, core, etc., assembled ready for casting.

It was customary to use when ramming the bottom box-part, shown at (A) Fig. 3, and bottom bell-box which covers the bottom flange B, strong milled sand. The box-part which carries the top-flange, and the box-part which covers the top flange (C and D) were rammed with similar sand, the body box-part (E) was rammed with a much weaker sand.



Composition and Manipulation of Moulding Sand.

The sand used was a red moulding sand quarried at Worksop, and is similar to the more widely-known Mansfield sand. Like moulding sands of other colours, it differs in its content of clayey matter. The analysis of the sand as it is delivered to the foundrymen would vary between the following limits: silica, 78 to 86; alumina, 5 to 8; ferric oxide, 2 to 3; lime, ½ to 3; and magnesia, 0 to 2 per cent.

Moulding sands are not generally supplied or controlled by analysis, and it is usually left to those who manage the work to ascertain how the varying sands should be treated. It is regrettable that often where several kinds of work are made which require sands differing in treatment, there exists a lack of supervision. It then devolves upon the mill-man, or some other person, to use his possibly erratic judgment regarding the constitution and length of time the mixture should remain in the mill. Hence, in works of large dimensions where several mills for loam and sands are at work, and possibly situated far apart, one mill-man's judgment will differ from another. So it happens that in one case the sand is milled three times as long as it should be; in another case it may not be milled half as long as it should be. In other cases mention might be made where lack of strengthening or weakening, opening, or cohesive material has been overlooked. Under such conditions it is not surprising that such happenings do occur when it is remembered that during the course of a day six different compositions of sand or loam are passed through one mill, and each case requiring different treatment for different classes of work.

Quality and Suitability of Iron.

An approximate analysis of the iron, which at times varied in its constituents, was as follows: Graphite carbon, 2.65 to 3.05; combined carbon, 0.40 to 0.60; manganese, 0.50 to 0.68; silicon, 2.30 to 2.50; sulphur, 0.02 to 0.03; and phosphorus, 1.54 to 1.55 per cent.

Now apart from any local characteristic, the analysis just quoted would indicate a grade of grey iron between a No. 3 and 4 Cleveland or Derbyshire brands, an iron which is quite suitable for the castings under consideration.

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In the case now under discussion the iron was blamed, when it really had nothing to do with the making of the wasters under consideration, and was not in any way responsible for the occurrence of liquid fracture.

Contraction of Cast Iron.

Cast iron contracts more or less according to section and composition, and it was thought in the present case by some that the trouble was due to contraction, as the length of the castings was seldom less than 9 ft., and often more than 12 ft. long. As the fracture unmistakably occurred while the iron was in a liquid or semi-liquid state, it cannot be entertained that solid contraction had anything whatever to do with the trouble. The difference in appearance between a cold or half-cold fracture and a "liquid" fracture is so distinct that which it is cannot be doubted. It was definitely ascertained that the fractures took place with a thin section casting within one minute after pouring.

Temperature of Iron when Pouring.

It was thought by some that the temperature of the iron when pouring the castings contributed to bring about the fracture. The temperature when pouring varied somewhat according to circumstances. Sometimes very hot (nearly dazzling white), at other times rather dull (not sluggish), but always very fluid, but it repeatedly happened that irrespective of the temperature of the iron when pouring, the undesirable fracture was present.

Design of Feeding Head and Thickness of Flange.

The design of the feeding head and thickness of flange in comparison with the body of the pipe was considered. In some cases the head was the full size of the flange, whilst with others it was designed ¾ in. extra allowed on the top of the flange for machining off, but it was repeatedly proved that the fracture occurred in either design. These designs are shown in Figs. 4 and 5.

The idea was then mooted that the pipe was "box-fast," i.e., the pipe could not contract, or, seeing that the body of the pipe was much thinner than the flange and heavy feeding head, that the heavy part was not cooling so rapidly as the thin body, and consequently the head and flange must pull itself away from the body as soon as that part was solidified. Obviously the pipe could not be "box-fast," as there was ample liberty everywhere, associated with a sufficient thickness of sand.

Unequal cooling was demonstrated to be an unimportant factor by stripping off the boxes and loosening sand around the flange in order to allow any contractions to take place without hindrance and to cool equally. This method is shown at C in Fig. 6. Obviously both halves were removed so quickly—sometimes within one or two minutes after pouring—that it constituted a most risky proceeding. Moisture, accumulation of gases and the like were considered, but the moulds were sufficiently dried, and provision regarding vents were ample for the escape of gases.

The waste work from this liquid fracture had been going on more or less for many months, the greatest mystery being that previously good results had been obtained by the same men and foreman, none of whom could now do the right thing. For a time every operation in making these castings was closely followed and reasoned out. Finally the writer came to the conclusion that the causes of the mischief lay in two directions, and fortunately these proved correct. Firstly, hard ramming immediately under the top flange (see G, Fig. 6). Secondly, strong milled sand used underneath that same flange.

When these two causes were discovered much softer ramming underneath the top flange was insisted upon, and the strong milled sand was discarded entirely, the writer personally supervising the softness of ramming and selecting the sand. The ramming was now done as usual up to about 3 in. from the bottom surface of the top flange, sand of a weak nature was then laid on loosely and the top flange bedded upon it and tucked around it lightly with a hand rammer, just sufficiently hard to prevent swelling and to resist the action of the liquid blacking in washing away, or disturbing the face of the sand.

When this procedure was carried out intelligently no sign of a liquid fracture was apparent. But it was difficult to persuade the men who were only semi-skilled moulders, that the reasons for the trouble given were the true reasons, and they would persistently say if the iron was hotter or cooler when poured, or if the iron was harder or softer, as the case may be, it would happen again. Also, if the box-part, C, Fig. 6, to which reference has been made, was not taken away and the sand stripped from the flange soon after it was cast, the same thing would happen again. All these doubts were met by proofs. The writer tested them all in practice. High and low temperature iron was tried. Hard and soft iron was used, and the box-parts were allowed to remain in position for one hour, and yet no fracture appeared.

One matter which delayed the ascertaining of the real cause earlier was the absence of scabbing. As a rule hard ramming or strong sand, either of which, and especially a combination of both, contributes to, and results in, scabbing. In these castings there existed not the least sign of scabbing. This may be accounted for by reason that the moulds were well dried and quite warm when poured.

Strong Sand.

Without going further into sand analysis, we shall fix upon the comparative amount of clayey matter or substance existing in the sand as delivered, and the amount of clean clay added to the sand as quarried which shall determine and constitute a weak, medium, or strong sand. When over-grinding a strong sand in a roller-mill in the absence of any opening or porous material it is possible to make it quite unfit for any moulding purpose. This is sometimes unwittingly done. The density of the sand is increased almost 50 per cent., consequently the porosity is reduced correspondingly. It often occurs when a weak sand only is obtainable the mill-man will add some clean raw clay to the sand to give it the desired strength, and in this he is sometimes successful, but more often than otherwise he fails. The same thing occurs, but in the opposite direction, when grinding loam when the loam is deemed too strong or too weak. Part-burnt sand is added in one case, and clay in the other, and the mill-man is very fortunate when he can add just the right amount and give it just the right time in grinding to make it perfectly suitable for various moulding operations.

Heat Treatment of Sands.

From close observations in practice, and by experiments made on heat treatment in relation to moulding sands of different strengths, the writer obtained the following results:—

1. That a core or mould made of milled weak sand, *i.e.*, low clay-content, when subject to great heat, as for thoroughly drying in a stove, the sand will expand considerably when at its highest heat, but when cooled down will be less than its original size.

2. That a core or mould made from medium-milled sand under the same conditions will expand more at its highest heat, and when cooled down will be about its original size.

3. That a core or mould made of strong-milled sand and subject to the same temperature under the same conditions as before, the sand will expand considerably more when at its highest temperature and will be larger when cooled down than the original size. These examples apply especially to bulk of sand, first-time heated, and have an important bearing in causing the liquid fracture under consideration, as will be shown.

Hard Ramming.

In all of the three examples just cited it has been shown that the harder the bulk of sand has been rammed in proportion will the density be, and consequently it naturally follows that as the density (which coincides with specific gravity) increases, so does the increase in expansion or swelling take place. That is to say, the harder the sand is rammed, so will the expansion increase. Thus, in each case the strength of the sand, in the absence of opening material, plus the hardness of ramming, when both are combined, practically increases the expansion two-fold. The amount of uncombined water contained in the sand in each of the foregoing would be 8 per cent.

From the illustration the actions will be clearly seen. Of course, the temperature of the iron and thickness of the casting would vary in time of setting, but in each case it can be assumed that

a medium temperature of the iron when pouring approximately 1,350 to 1,400 deg. C., and the thickness of the casting, will be what is quite common in practice: section of pipe ¾ in.; thickness of flange, 2 in., machining allowance inclusive; diameter of pipe, 18 in.

With reference to Fig. 7, it should be pointed out that the small circles represent ordinary floor ramming sand used for this class of work, which is fairly weak. The carbon blacking-wash forms the skin of the mould and preserves the sand against fusion. The boxes remain intact until the pipe is ready for stripping, thus excluding the oxygen in the air. This considerably prevents the sand from burning. This sand is used over and over again, being moistened every time with thin clay wash and occasionally some new sand added to compensate for loss in bond and bulk.

The crosses represent strong milled sand such as has been described.

The weak sand indicated by the arrow is, and must necessarily be, rammed hard from 3 in. below the top flange to prevent swelling, but in cases where the rupture developed, the strong sand was also rammed hard. When the casting was poured, which is done through gates at the top, the fluid iron rises rapidly to the top flange. The section of the casting, which is ¾ in., is frozen in 2 minutes or less. The flange, with the increased bulk of the head, will remain fluid, and in a pasty condition for about 3½ in. Thus it is between the time that the ¾ in. section becomes frozen and the period that the larger area of the flange and dross head remains liquid or pasty that the liquid fracture or rupture occurs. When the iron rises to the hard rammed strong sand, represented by the crosses, the great heat imparted to it from the high temperature of the fluid iron causes it to swell. The swelling or expansion of the strong sand may, or may not, be infinitely small. However that may be, it is certain the sand can only expand one way, that is toward the flange from the underside indicated by an arrow. This is the line of least resistance, and obviously it can only expand in that direction when the iron is in a liquid or pasty condition. That is what actually happens, because the box-parts and the necessary hard-rammed sand underneath prevent the expansion of the strong or hard-rammed following in any other direction. Assuming that the ¾ in. section becomes frozen in two minutes and the flange in 3½ minutes, so that the fracture takes place between 2 and 3 minutes, regardless of the thin section being set. The flange being liquid, the least possible pressure underneath the flange upwards would be sufficient to make a parting, however slight, at the point where the frozen and pasty conditions exist at the moment.

Cooling Expansions.

During this investigation the writer considered the possibility of cooling expansions and contractions, as shown by W. J. Keep and Professor Turner, synchronising with the liquid fracture at perhaps the first critical period.

Seeing that a ¾ in. section was in close proximity to a section the area of which would be about 3 in., the writer thought that each phenomenon may exert some influence in that direction by the thin section solidifying, then expanding, and again contracting from the thick area during the time that part was in a liquid or pasty state

Keep demonstrated by his cooling curve recorder that there are three expansions in grey cast iron, which commences after solidification, but had not ascertained the exact temperature at which these expansions took place, and states: "Should the expansions occur at the temperature of 850 deg., 750 deg., and 650 deg. C., which corresponds to the critical points A 3, 2, and 1, concludes that the expansion curves are caused by a rearrangement of crystals, and is purely a physical process."

Prof. Turner ascertained later the temperature of these arrests and expansions which occurred at 1,100 deg., 900 deg., and 700 deg. C. respectively, and that the arrests corresponded with the separation of primary graphite, formation of iron-phosphorus-carbon eutectic, and secondary graphite, and mentions that length only was observed, and not volume.

Now the melting point, which is also the freezing point, of grey cast iron containing an appreciable amount of phosphorus, would be about 1,200 deg. C. Turner gives the first expansion after solidification at 1,100 deg. C. Referring to Fig. 7, the ¾ in. section of the casting is approximately estimated to solidify on a warm dry sand mould within 2 min., and the largest area to solidify in not less than 3½ min. The direct point of reasoning by the writer is that it is not difficult to conceive that the ¾ in. section would solidify and pass the first expansion at 1,000 deg. C. with contraction following on, whilst the thick section above the fracture was in a semi-liquid or pasty condition. If that were so and there existed any resistance, such as hard-rammed strong sand, to prevent the flange area of pasty iron following the contraction of the ¾ in. sections, it may considerably hasten and promote the trouble under discussion. Whether such events are likely, or unlikely, to happen the writer will leave an open question. It is highly satisfactory to know that the mischief, which was a very real one, is now avoided.

Pure and Applied Science.

A Closer Union Advocated.

There was the usually good muster of members of the South Wales Institute of Engineers and their friends at a special meeting held on March 23 at Cardiff. The meeting had been called to hear an address by Dr. E. H. Griffiths, F.R.S., Cambridge, ex-Principal of the South Wales and Monmouthshire University College, and a former President of the Institute, on "The Closer Union Between Pure and Applied science."

One of the visitors was Mr. W. B. Worthington (President of the Institution of Civil Engineers), to whom a cordial welcome was given by the President, Mr. David E. Roberts.

Mr. Worthington expressed the pleasure it afforded him to meet so flourishing and well-known a scientific society as the South Wales Institute of Engineers, and mentioned that Dr. Griffiths and he were fellow-students at Owen's College, Manchester, fifty years ago.

Prefacing his address by intimating that what he had to say about pure and applied science was mainly intended for the young engineer and chemist, Dr. Griffiths recalled some of the British industries that were captured and developed by the foreigner because of the lack of foresight and of encouragement of our scientists by the Government and industrial magnates at home since the first half of the last century. Thus he urged the urgent necessity, if we wished to see a permanent revival of trade in this country, for a closer relationship between the laboratory and the market place. In this co-operation lay the chief hope of any future advance. In the past our great industries had been controlled by able business men with no scientific knowledge, and with little respect for it. It was the rule-of-thumb era. Germany profited by our mistakes, believing that a sound scientific knowledge was the basis of industrial success. She applied this knowledge not only to her own industries but those of other countries. The names of the men who were making the basic discoveries on which industries were, or could be, established were not to be found in any German list, but in British and French lists. But the English business man had not been prepared to supply capital for research until the application of a discovery had proved a commercial success. Here was to be found the chief cause of our failure, when compared with the Germans. But there were many reasons for regarding the present time very hopefully. It was believed we were entering upon an era of great discoveries in natural science, the work of Sir Joseph Thomson, Sir Ernest Rutherford, and others having revealed the marvellous constitution of the atom and the nature of the chemical elements. There was no discovery in science which could not be utilised if we had the wit to apply it. In the ability to drive this into the minds of business men, more especially by our young engineers, our chief hope lay. He advised the young engineer and chemist to go back to natural phenomena, because he ventured to predict that they would have to rely upon the direct rather than the indirect utilisation of the energy supplied by nature. He deprecated over-specialisation; the engineer should have easy access to all chambers in the Temple of Science.

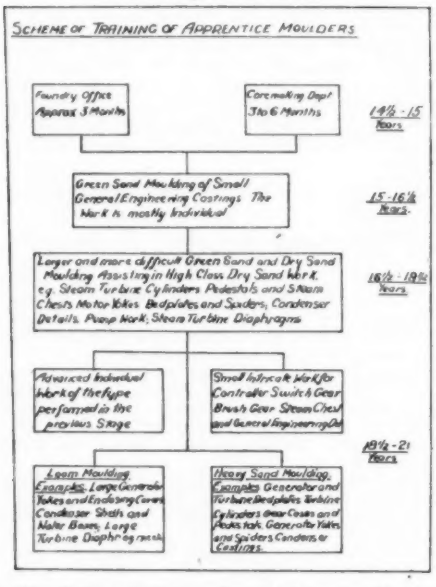
Mr. George C. Riley has been appointed secretary to the Hodbarrow Mining Company, Millom, in succession to Mr. S. Wilson, who for some years has suffered from ill-health. Mr. Wilson has been in the employ of the Hodbarrow Company for 44 years, and Mr. Riley has also been with the firm during the whole of his business career.

Some Aspects of Foundry Training.

By H. J. Brocklehurst, M.Eng., A.M.I.C.E., and T. Makenson.

Usually the pattern shop and foundry receive inadequate treatment when schemes of engineering training are considered, with the result that there is to-day in the engineering world a conspicuous

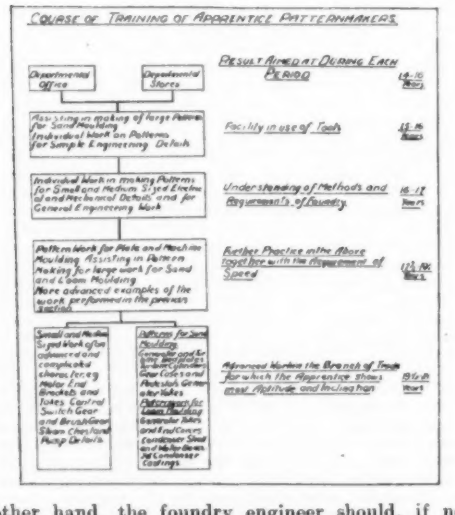
Form I.—*Diagrammatic Representation of the Scheme for Moulders.*


Scheme of Training of Apprentice Moulders.
Foundry Office Approx 3 Months
Core making Dept 3 to 6 Months
14½ - 15 Years
Green Sand Moulding of Small General Engineering Castings. The Work is mostly Individual
15 - 16½ Years.
Larger and more difficult Green Sand and Dry Sand Moulding Apprentice in High Class Dry Sand Work e.g. Steam Turbine Cylinders Pedestals and Steam Chests Motor Yokes Bedplates and Spiders, Condenser Details, Pump Work, Steam Turbine Diaphragms
16½ - 19½ Years
Advanced Individual Work of the type performed in the previous Stage
Small Intricate Work for Controller Switch Gear Brush Gear Steam Chest and General Engineering Job
19½ - 21 Years
Loam Moulding Examples. Large Generator Yokes and Enclosing Covers Condenser Shells and Water Boxes, Large Turbine Diaphragms etc.
Heavy Sand Moulding. Examples Generator and Turbine Bedplates, Turbine Cylinders Gear Cases and Pedestals, Generator Yokes and Spiders Condensers or Castings.

dearth of first-class foundry engineers. In speaking of foundry engineers we need to distinguish between the artisan moulder or core-maker, and the official who is responsible for the organisation of foundry processes; the former we describe as a workman, the latter as an engineer. Since the functions which each of these two grades of foundry personnel are required to undertake are essentially different, consequently the requisite training necessarily differs in each of the two cases.

Generally speaking, the foundry workman is recruited from the trade apprentice, who enters industry prior to his sixteenth birthday; on the

Form II.—*The Scheme for Apprentice Pattern-makers.*


Course of Training of Apprentice Pattern Makers.
Result Aimed at During Each Period
Departmental Office
Departmental Stores
Assisting in making of large Patterns for Sand Moulding. Individual Work on Patterns for Simple Engineering Details
Facility in use of Tools
Individual Work in making Patterns for Small and Medium Sized Engine Gland Mechanical Details, and for General Engineering Work
Understanding of Methods and Requirements of Foundry
Pattern Work for Plate and Machine Moulding. Assisting in Pattern Making for large work for Sand and Loam Moulding. More advanced examples of the work performed in the previous Section
Further Practice in the Above together with the Requirement of Speed
Small and Medium Sized Work of the advanced and complicated characters eg. Motor End Brackets and Yokes, Control Switch Gear and Brush Gear, Steam Chest and Pump Details
Patterns for Sand Moulding. Comprising Generator Yokes, Brush Gear Cases and Pedestals, Generator Yokes and Motor Boxes, Patternwork for Loam Moulding Generator Yokes and End Covers, Condenser Shells and Motor Boxes, All Condenser Castings
Advanced Work in the Branch of Trade for which the Apprentice shows most Aptitude and Inclination

other hand, the foundry engineer should, if not always at the present, be recruited from young men who have received secondary or university education. At the same time, however, ample facilities should exist in each foundry for the promotion of youths and young men who start in life as artisan workers, to positions of responsibility as foundry engineers, if they possess the inherent capacity requisite to participate in this wider sphere.

It should be noted that the type of foundry engineer that is visualised in this article, and whose training is analysed, is a very rare product to-day in the foundry world. Most of our foundries are under the control of men who have acquired their knowledge by practical experience; men who were originally working moulders or pattern makers and who by dint of force of character and special ability have risen to positions of responsibility. It is not suggested that the day of such men as these has passed; at the same time, however, the foundry trade has assumed the dimensions of a very complex industry, and the time seems opportune definitely to train men for positions of responsibility in foundry management rather than to recruit the foundry manager or engineer entirely from the ranks.

We have, therefore, two types of personnel to consider with their respective apprenticeship periods. We will in the first place consider the selection and training of trade apprentices.

Trade Apprentices.

Complete training in the engineering trades involves a dual type of instruction, requiring, on the one hand, experience in the practice of the trade, and, on the other, a sound knowledge of the principles underlying trade practice. In the foundry we find a large number of skilled craftsmen, who, while being adepts in the art of moulding, considered from a purely manual point of view, lack a knowledge sufficient to enable them to function in all the varying conditions which arise in a modern foundry.

Respecting practical experience in the foundry itself, the writers are of opinion that in all except the smallest foundries the existing organisation of foremen, etc., is insufficient to ensure that apprentices receive proper and adequate training. It should be the whole or part time responsibility of some one individual to move among the apprentices in giving them the necessary instruction in craft skill. In one large foundry an apprentice-instructor is appointed, who is himself a skilled craftsman, but, in addition, possesses sound technical knowledge and good teaching capacity. The instructor is in constant contact with the apprentices, supervises their work, and sees that each apprentice gets the best experience possible. It is the aim of the instructor definitely to impart those necessary parts of the craftsman's knowledge which would otherwise be left to haphazard circumstances. The apprentice instructor would also be responsible for the selection of apprentices who apply for admission to the foundry.

In general the trade apprentice should spend his whole time in either the pattern shop or foundry, and a suitable sequence of practical training is set forth in Forms 1 and 2 respectively. Necessarily these diagrams relate to a particular works, but their general application will be appreciated.

In connection with the practical training of apprentices in the foundry and pattern shop, some means should be provided for determining from time to time the progress which apprentices are making. Too often apprentices rely on workmen and others in their immediate vicinity for continuous help, and although within limits this is very necessary, some means should exist for gauging the extent to which the apprentice is acquiring ability to act independently of his associates. In order to achieve this a suitable device is the holding of regular practical examinations for apprentices in the foundry and pattern shop. It is unwise to introduce test exercises specially designed for examination purposes, but every test should be an ordinary productive job suited to the skill and experience which a boy at any given age is supposed to possess. Perhaps the most important result to be obtained from such a form of examination is the marked increase of the standard of workmanship which will result. Many apprentices, perhaps for the first time in their industrial career, will be required to undertake work of a direct productive character without being able to obtain the slightest assistance from any other source. Such a condition provides apprentices with opportunities

for introspection, and they find that their own practical ability is not so far advanced as they had imagined. The natural result of such a realisation of limitation of capacity is that the boys are spurred on to better achievement and stimulated to a higher standard of workmanship.

Moreover, such practical examinations provide foremen with a uniform standard by which to judge the ability and progress of apprentices, and this knowledge can be turned to useful account in promoting boys to more advanced work.

In addition to shop instruction it is essential that instruction be given in the scientific principles underlying foundry processes and methods. It is agreed that in no industry are scientific principles being made use of to a greater extent than in the foundry industry, but many of the natural laws which are called into operation in the foundry are but little understood by the men engaged in that work. Much foundry work is founded upon mere empiricism. A foundryman may, and frequently does, by dint of his own efforts, become acquainted with much knowledge of the principles of his craft, but the time has arrived when such knowledge should be definitely and systematically imparted to him. Such knowledge could be most conveniently acquired through the medium of some form of class-room instruction. In many industrial centres foundry classes are being held in connection with the local technical schools or colleges. Many of these classes are attended, not only by apprentices, but by foremen and workmen who realise the deficiencies of their previous training. The average apprentice, however, is frequently too tired, both mentally and physically, after his day's work in the foundry to apply himself with the requisite amount of concentration to evening study, and it is probably only the apprentice of exceptional character who benefits by such agencies. It is much better if the apprentice can attend such a class during the day-time, and several large firms now provide classes for their foundry apprentices in their works during works hours.

In such a class the utmost care must be exercised in the drawing up of the curriculum. It must be constantly borne in mind that the function of the class is to impart necessary trade knowledge, but trade knowledge of a character not readily acquired in the foundry itself. While a certain amount of so-called "theory" will be dealt with, every effort must be made to guard against proceeding on academic lines. It is the experience of the writers that such trade classes are extremely successful when the teacher definitely aims at the goal of making his pupils master of their craft in the broadest sense of the term. If any confusion is allowed to exist in such a way as to introduce matter of a semi-technical character, then the best results will not be achieved. Such classes as are here outlined are intended for all apprentices in any given works; the existing facilities for technical training will, to a large extent, meet the requirements of the exceptional boy who wishes to fit himself for some higher position, and such boys should be given every encouragement to take advantage of these facilities.

Foundry Engineering Apprentices.

Reference has already been made to the foundry engineering apprentice as distinct from the artisan apprentice. In general, the former type of apprentice will be recruited from a public or secondary school, and in many cases from a Faculty of Engineering of a University, and undertake training for a period varying from two to four years. It should be recognised that foundry engineering is a separate profession, and the training requires to be on different lines from the training for other branches of engineering. The foundry engineer should be something of a metallurgist and something of a general engineer, and, at the same time, should have sufficient practical experience of purely foundry matters to enable him to use his general engineering and his metallurgical knowledge for the control of foundry processes.

In the case of foundry engineering, apprentices who have had sound technical training, both in engineering and metallurgy before they enter the works, will only require to study foundry processes, and it is desirable that this study should be undertaken as far as possible from the point of view of the moulder and pattern-maker, so that the apprentice actually gets down to productive work, and works alongside the moulder, coremaker and pattern-maker. On the other hand, the foundry-engineering apprentice who enters the works direct from public or secondary schools will require to obtain his technical training, both engineering and metallurgical, through the medium of evening classes at a local technical college, which study will be undertaken in parallel with his practical foundry training during the day-time.

As the foundry-engineering apprentice nears the completion of his training course, it would be well to attach him to the foundry manager as a personal assistant, in order that he may have an opportunity of studying some of the special problems which arise in foundry management. This training would also include some experience in the organising of foundry production.

The following table suggests an appropriate course of training for foundry engineering apprentices :—

Core-making	2	months.
Small moulding	5	,,
Medium moulding	9	,,
Brass foundry	5	,,
Pattern shop	9	,,
Chemical laboratory	6	,,
Mechanical testing	3	,,
Heavy sand and loam moulding	6	,,
Cupolas	1	,,
Personal assistant to foundry manager	2	,,

In the case of men who have had previous university training, the above programme would be shortened, but only in point of time.

Training of Adult Semi-Skilled Workers.

With the development of plate and machine moulding, increasing use has been made in foundries of semi-skilled workers. For a considerable period inadequate attention has been devoted to the training of this grade of foundry labour, and, frequently, especially in large foundries, production has been greatly retarded and a high percentage of wasters produced as a result of the imperfect knowledge possessed by such semi-skilled workers. Whatever training these men get is usually given by the foremen and by fellow-workmen; in a large foundry, however, the causes which make the training of apprentices imperative also indicate the necessity for some systematic training of semi-skilled workers. It is necessary that new men without previous experience should be taught, and that new men who have had experience elsewhere should be coached in the methods of their new employer. This kind of training may be provided for either by an instructor working on the same lines as the apprentice instructor, or by a course in a special training foundry attached to the main foundry.

Publications Received.

MELDRUMS, LIMITED, Timperley, near Manchester. "Forced Draught Furnaces and Mechanical Stokers," with descriptive particulars and illustrations.

METROPOLITAN-VICKERS ELECTRICAL COMPANY, LIMITED, Trafford Park, Manchester. Special publications dealing with "Planer Drives" (individual drive control of machine tools), and "Power in the Textile Mill."

THE VAUGHAN CRANE COMPANY, LIMITED, Openshaw, Manchester. Illustrated booklet of "The Vaughan Overhead Crane."

"BULLETIN OF THE CLEVELAND TECHNICAL INSTITUTE, MARCH, 1922." Offices: Corporation Road, Middlesbrough.

A MEETING OF MEMBERS of the Institute of Metals will be held on May 3, when Professor Sir Ernest Rutherford will lecture on the subject of "The Relation of the Elements."

ADDRESSING the Institution of Civil Engineers on "Corrosion of Ferrous Metals" recently, Sir Robert Hadfield said that for the year 1920 the loss by rusting in use was estimated for the world at 29 million tons, and for that year, with steel at £20 per ton, and after making allowances for protection, etc., the annual cost of wastage was probably over £700,000,000.

Cupola Practice.*

By J. Wood.

The object of this article is to point out some of the difficulties that have to be overcome in melting iron by the cupola process. There are many other ways in which iron may be melted, namely, by the electric furnace, the reverberatory or air furnace, the open-hearth furnace, and the crucible furnace, but for quickness and cheapness in melting iron the cupola cannot be excelled by any other furnace that is on the market at the present time. The greatest drawback to the cupola furnace is that the iron is in contact with the fuel the whole time and will take up some of its impurities if not properly cared for. The cupola is simple in construction and will need very little describing. It is probably due to its simple construction that it has been overlooked by the majority of ironfounders until quite recently, when judging by the interest they seem to be taking now, they are beginning to realise that it is an important factor in the successful working of a foundry.

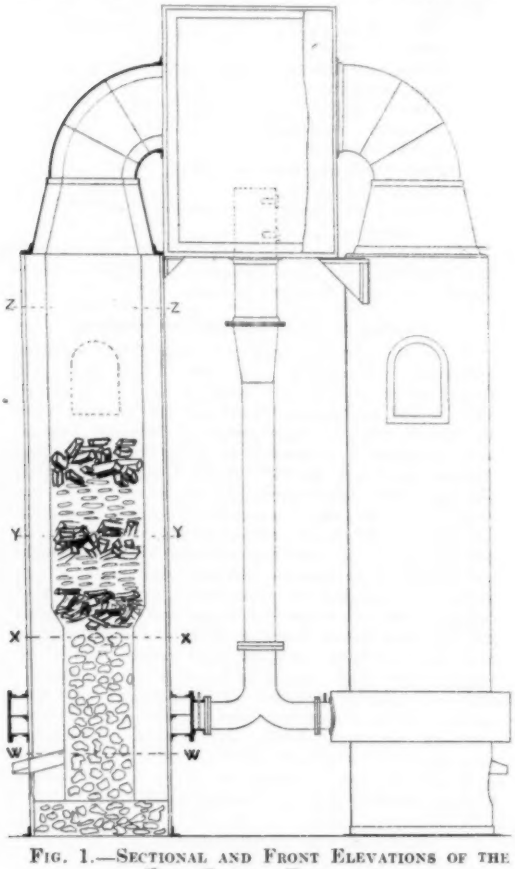


Fig. 1.—Sectional and Front Elevations of the Twin Cupolas Described.

Details of the Cupola Dealt With

The cupola to be dealt with is shown in Fig. 1. These cupolas are built in pairs and are worked alternately; that is, whilst one is in operation the other is undergoing repairs that are necessary after each day's blow. They are made up of mild steel tubes, 6 ft. 6 in. diameter and $\frac{3}{8}$ in. thick. These tubes are rivetted together and form the shell. On the inside of the shell angle irons are bolted for the purpose of supporting the brickwork lining. The distance from the base plate to the top of the stack is 26 ft. On top of the stack is rivetted an elbow, and it is in this respect these cupolas differ from the majority. Generally, cupolas are built with a straight stack, on the top of which is placed a hood to prevent the sparks and dust from blowing on the foundry roof. Instead of a hood this type is provided with a square box, which rests on brackets rivetted to the stack of the cupolas and also bolted to the ends of the elbows. Openings are made in the sides of this box opposite the ends of the elbows. As the sparks and coke dust are forced by the blast up the stack, they strike against the elbow, which stops their upward motion, and are then blown into the box and fall to the bottom. An opening is made in the bottom of the box, around which is bolted a tube which may pass through the stage plates to within a few feet of the ground. A slide worked with a screw is fixed near the bottom of the tube. To remove the coke dust, etc., a barrow is placed beneath the tube, the slide is opened, and the barrow is filled in a few seconds. This greatly facilitates the handling of the coke dust, as it may be removed at any time of the day whether the cupola is in operation or not.

The distance from the base plate to the bottom of the hearth is 2 ft. 4 in. This space is filled up with broken bricks and floor sand rammed tightly. This is levelled off with a 2-in. layer of fireclay. The hearth is made on top of this. The distance from the top of the hearth to the centre of the slag notch is 1 ft. 3 in. From the centre of the slag notch to the centre of the bottom row of tuyeres is 9 in., and from the bottom row of tuyeres to the top row is 1 ft. 2 in. There are eight of these tuyeres, four in the bottom row and four in the top row, each of 6 in. dia. They are placed alternately and are so arranged that the inside ends are equi-distant from each other so that they give an equal distribution of blast. These tuyeres are provided with a wind belt.

The Lining.

Owing to the high temperatures to which it is subjected, the lining must be made of highly refractory material and must also be strong enough to withstand the abrasive action of the material charged on its way down to the melting zone. Too much care cannot be taken to avoid cracks and open joints in building the lining, as the molten metal and hot gases would penetrate these and shorten its life. The material used for lining cupolas is aluminous firebricks or blocks. The thickness of the lining will depend on the amount of metal required in the day's blow, but even in small cupolas the lining should not be less than 6 in. thick. It is better and safer to have a double lining than a single one, as in the event of an open joint being overlooked in the well of the furnace, the metal would find its way along the joint to the casing and probably put an end to the day's blow. Whereas with a double lining and bricks placed cross joint, the progress of the molten iron would be checked and the damage prevented. When pulling out the old lining it has been noticed that the metal has run between the badly jointed bricks and also between the inner and outer circle, but fortunately has not reached the casing or shell. It is many years since the author has had damage done to the casing by the liquid metal attack, which speaks well for the cupola linings and the material used. It is interesting to note that the cupola linings under the author's control last approximately twelve months. With cupolas that require a 9-in. lining or less it is advisable to maintain the thickness to the top of the charging door, above this a thinner lining of about 4 in. thick will be sufficient, because it will not be subjected to the same wear and tear as the lining below the charging door. With a cupola having a 12-in. lining or more it is only necessary to carry this thickness to the top of the melting zone, which may be from 20 in. to 30 in. above the top tuyeres. Obviously, the height of the melting zone will depend on the diameter of the cupola and the amount of air delivered. Above this, the thickness of the lining may be reduced, but not less than 9 in. This, of course, will cause a shoulder in the lining, but if properly tapered off, will not affect either the cupola or melting. There is no advantage in this except a saving of bricks. A further economy may be made by using hollow iron blocks, which may be inserted about 3 ft. 6 in. above the melting zone and carried to the top of the charging door. These blocks will

* A Paper read before the Lancashire Branch of the Institution of British Foundrymen.

last a considerable time. With the exception of the lower two or three courses and those directly opposite the charging door, the blocks are very little worse at the end of twelve months' work, and may be replaced at a higher point in the cupola when relining. The diameter of the cupola after lining is 3 ft. 6 in. up to the top of the melting zone, which is approximately 2 ft. 6 in. above the top tuyeres. It then tapers off 4½ in. all round, making the diameter 4 ft. 3 in. This is continued to the top of the stack. The elbow is lined with 9-in. blocks and the spark arrester with square quarries 1½-in. thick. Fig. 2 shows the author's method of lining the cupolas.

Tuyeres.

As stated, the cupolas are provided with two rows of tuyeres, four in each row, and each of 6 in. diameter. They are provided with a wind belt, the area of which is 63,480 cub. in. The ratio of the combined tuyere area to that of the wind belt is as 1: 280. This allows for a sufficient accumulation of air to ensure an equal distribution of blast and a constant pressure provided that the delivery is maintained. The relation of the tuyere area to the cross sectional area of the cupola is as 1: 6, the combined tuyere area being

When charging for the afternoon the furnace is red hot, and the extra coke that was given in the morning's blow to heat up the lining is not needed. Some of the heat from the red-hot furnace is transferred to the iron charged, and when the blast is put on and the hot gases ascend the cupola from the melting zone the red-hot lining will absorb less heat from these gases, and more heat will thus be transferred to the charges of metal, and they will enter the melting zone in a much hotter condition and be more readily melted. The result of this is that the afternoon's blow is started at the same rate of melting as the latter part of the morning's blow, and as the melting continues the furnace becomes hotter and the rate of melting is increased proportionately. The average rate of melting over the full day's blow is 8½ tons per hour.

Disturbing Factors.

The above results are only obtainable under favourable conditions, but unfortunately there are many things that may happen, any one of which is apt to upset the results. To mention a few: The coke may be of an inferior quality; the charges of iron may be too heavy or too light; the charges may not be distributed evenly; the coke may not be spread evenly over the charge; the

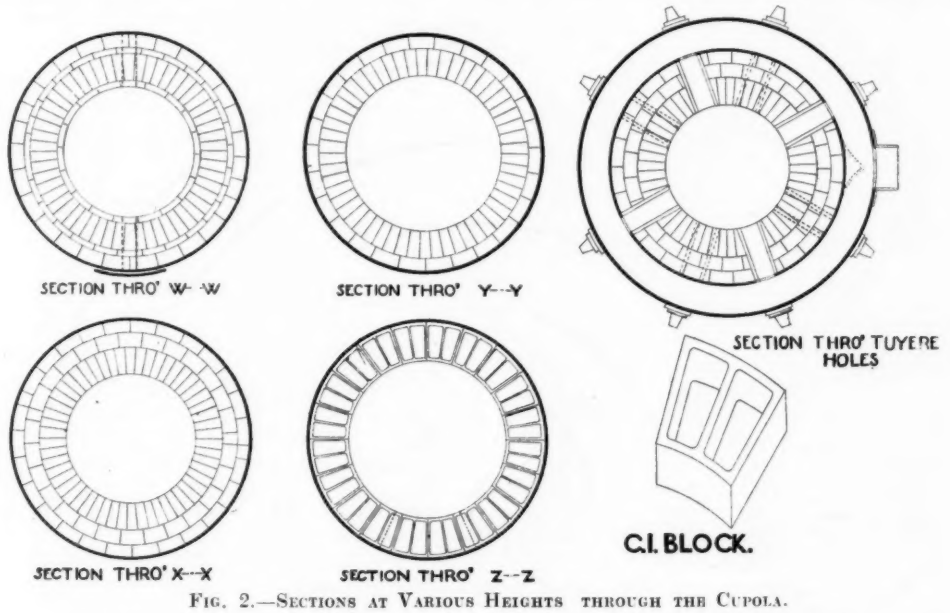


Fig. 2.—Sections at Various Heights through the Cupola.

226 sq. in. and the cross sectional area of the cupola 1,385 sq. in. The air necessary for combustion is delivered by a Roots blower and conveyed in overhead pipes to the wind belt. A blast pressure of from 10 to 14 ozs. is maintained, and the volume gauge registers an average delivery of 3,750 cub. ft. of air per minute. Experts say that 30,000 cub. ft. of air is required to melt a ton of iron and the authors records taken over a long period confirm this. If the delivery of 3,750 cub. ft. per minute is taken it will take eight minutes to deliver 30,000 cub. ft. and to melt one ton of iron. This works out at exactly 7½ tons per hour, as shown in Fig. 3. The works records show on a full day's blow of 50 tons per cupola rather better results than this, but this is accounted for by the furnace conditions. For example, when the metal is first charged into the cupola the lining is comparatively cold. After the blast is put on and more heat generated, a large amount of this heat that should go to pre-heat the iron before it reaches the melting zone is absorbed by the lining. To make up for this loss of heat it is advisable to charge with a little extra coke until the lining has become thoroughly heated. Of course, this extra coke will retard the melting a little, and each of the first three or four charges will require rather more than eight minutes to melt, but as the furnace becomes hotter and the charges above the melting zone receive the benefit of this heat, the extra coke may be left off, and there will be a perceptible increase in the rate of melting. But this is more noticeable in the afternoon's blow.

volume of blast may be too low and the pressure too high; there may be a scaffolding of charges or a chambering of the cupola; neglecting the repairing of cupola by letting it get out of shape; neglecting the slag hole and projecting lower part of the tuyeres and several other faults, any of which may upset the proper working conditions of the furnace and cause bad melting and an inferior quality of iron.

Bad-Coke Troubles.

Apart from any of these faults happening, it is still necessary, to get the very best results from the cupola, to have a good coke and a good supply of air. Fortunately, there is plenty of the latter, and it can be obtained cheaply. With regard to the former, it is found that when dealing with the best makers there is very little to complain of about the quality of coke. Of course, an occasional wagon of bad coke sometimes turns up, but it is the exception rather than the rule, and probably the coke, like the rest of the foundry materials, often get the blame that is really due to the human element. During the coal crisis and for several weeks afterwards when foundry coke was unobtainable, anything that had the appearance of coke had to be used. Some of this contained as much as 17 per cent. ash and 1.75 per cent. sulphur, but the worst feature about some of these cokes was not its composition, but its structure. Some of this was so friable that it could be crushed with the foot, so it can be imagined what the effect would be when dropping pig-iron

on top of it from a height of 11 or 12 ft. When using coke of the above description, it was found necessary to increase the depth of the bed coke from 6 to 9 in. to allow for the crushing effect of the first charge. The weight of charges were also reduced from 20 to 17 cwts., and a little extra coke was allowed between each of the charges. This answered very well, and it can be stated that castings were produced without any serious increase of wasters and without the loss of a single day's output.

A coke that is chemically bad but has a fairly strong structure can, by taking proper precautions, be used with satisfactory results. For instance, with the analysis given above, this coke can only contain at the most 80 per cent. carbon. Assuming that it takes 200 lbs. of coke containing 90 per cent. carbon to melt one ton of iron, then 200 lbs. of coke containing 90 per cent. carbon equals 180 lbs. of carbon, and 200 lbs. of coke containing 80 per cent. of carbon equals 160 lbs. of carbon. Assuming that the blower or fan is capable of delivering the requisite amount of air, namely, 30,000 cub. ft. per ton in a given time, and that the tuyere area is such as to take the amount delivered, and the supply of air is constant in both cases, then one is trying to melt the same amount of iron with 20 lbs. less of carbon or 25 lbs. of coke, which is its equivalent, or in other words, instead of having sufficient coke to melt 2,240 lbs. of iron, we have only sufficient coke to melt approximately 2,000 lbs., thus leaving 240 lbs. to be melted. The consequence of this will be, although it may not be noticeable at the first or second charge melted, that to melt this 240 lbs. of iron it will have to draw upon the coke bed to the extent of 25 lbs. of coke for the first charge. The bed will be 50 lbs. of coke less after the second charge, and so on, until the bed is so lowered by the extra demand upon it that the metal is in close proximity to the tuyeres.

It is common knowledge what takes place under such circumstances, as the bed is gradually lowered the temperature of the metal falls off and there is an excess of oxygen over the carbon in the fuel. The result of this is that the iron becomes oxidised, runs sluggishly, and is only fit for castings that have not to be machined or tested. Further, the bed may become so low that the cold-blast will blow upon the iron and instead of melting, it becomes chilled and sticks to the sides of the cupola chambers, and if only one row of tuyeres are used stops further blowing for that day. The obvious remedy when using a low-carbon coke is to increase either the quantity of coke or reduce the weight of the charges. All foundries have not got a chemist to advise them as to the carbon-content of the coke, but to those who are trying a coke, to which they have not been accustomed, and are not sure as to its quality, it is suggested that they try lighter charges than usual when filling up the cupola. Then by watching the rate of melting and the temperature of the metal as it flows from the cupola, it will be an easy matter to regulate the weight of metal in the succeeding charges to suit the coke.

High-Sulphur Coke.

The influence of high-sulphur-content of the coke can be neutralised to a great extent by the mixing of suitable brands of iron and by quick melting. It is well known that manganese has a strong affinity for sulphur. When we know or suspect that a coke is high in sulphur we mix a quantity of high manganese iron with the charge. The manganese will combine with the sulphur in the coke forming manganese sulphide. This will rise to the top of the molten metal and flow off with the slag. Some people try to eliminate the sulphur by using extra limestone, but the author prefers to use manganiferous irons, as an excess of limestone is apt to do more harm than good, as it will combine with the brickwork lining of the cupola and lower its fusibility, which will necessitate extensive repairs. Where the services of a chemist are not available, the presence of high sulphur can be detected at the cupola spout. An iron that has absorbed a large amount of sulphur from the fuel gives off sulphur dioxide fumes, which have rather a strong smell. The first charge of iron tapped, owing to its long contact with the coke, invariably contains more sulphur than the succeeding charges, and which, by the way, should not be used for small castings that have to be machined. If the succeeding charges should give off these fumes then steps should be taken to eliminate some of the sulphur by the above means. If the means are not at hand, either in the shape of high manganese irons or ferro-manganese, and soft castings are required, then the silicon content of the mixture should be increased.

(To be continued.)

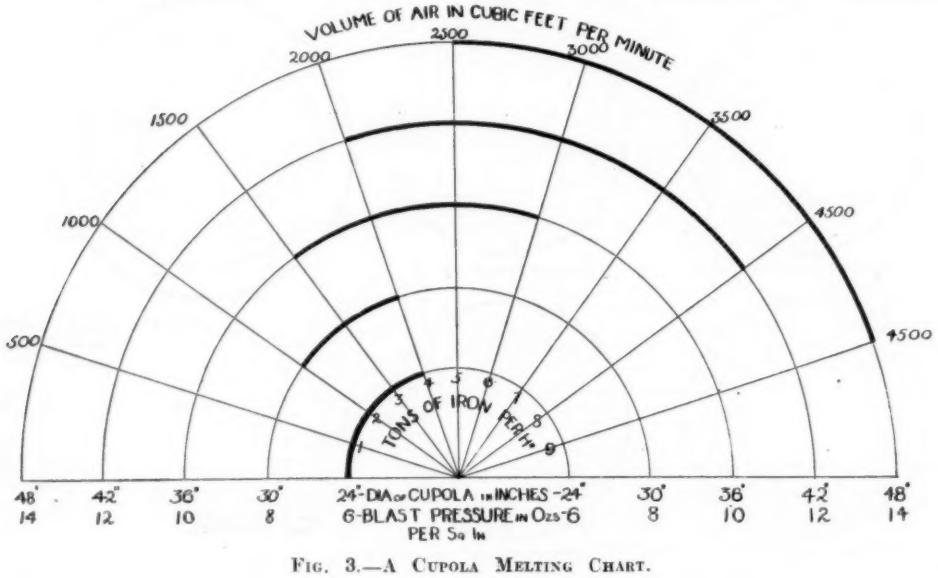


Fig. 3.—A Cupola Melting Chart.

The Institution of Production Engineers.—A general meeting will be held at 7.30 p.m. on April 21, at the Institution of Mechanical Engineers, Storey's Gate, London, S.W., when Mr. J. R. Smith, A.M.I.E.E., of Messrs. J. & E. Hall, Limited, Dartford, will read a Paper on "Electricity in a Machine Shop."

Steel Mills in Pittsburgh District.—Largely increased operations in the plants of the Carnegie Steel Company throughout the Pittsburgh district are assured by the announcement just made that the 72- and 110-in. mills at the Homestead plant were to be re-opened at once, and that idle departments at the Duquesne plant were also to start work this week. This assures practically complete operation of two of the Company's largest units. All blast furnaces at these plants are to be blown in next week. The last of the group of furnaces in Farrell, Pa., will be blown in within the next few days, while continued activity for the Youngstown district was announced in official quarters.

How Patterns are Altered.—I.

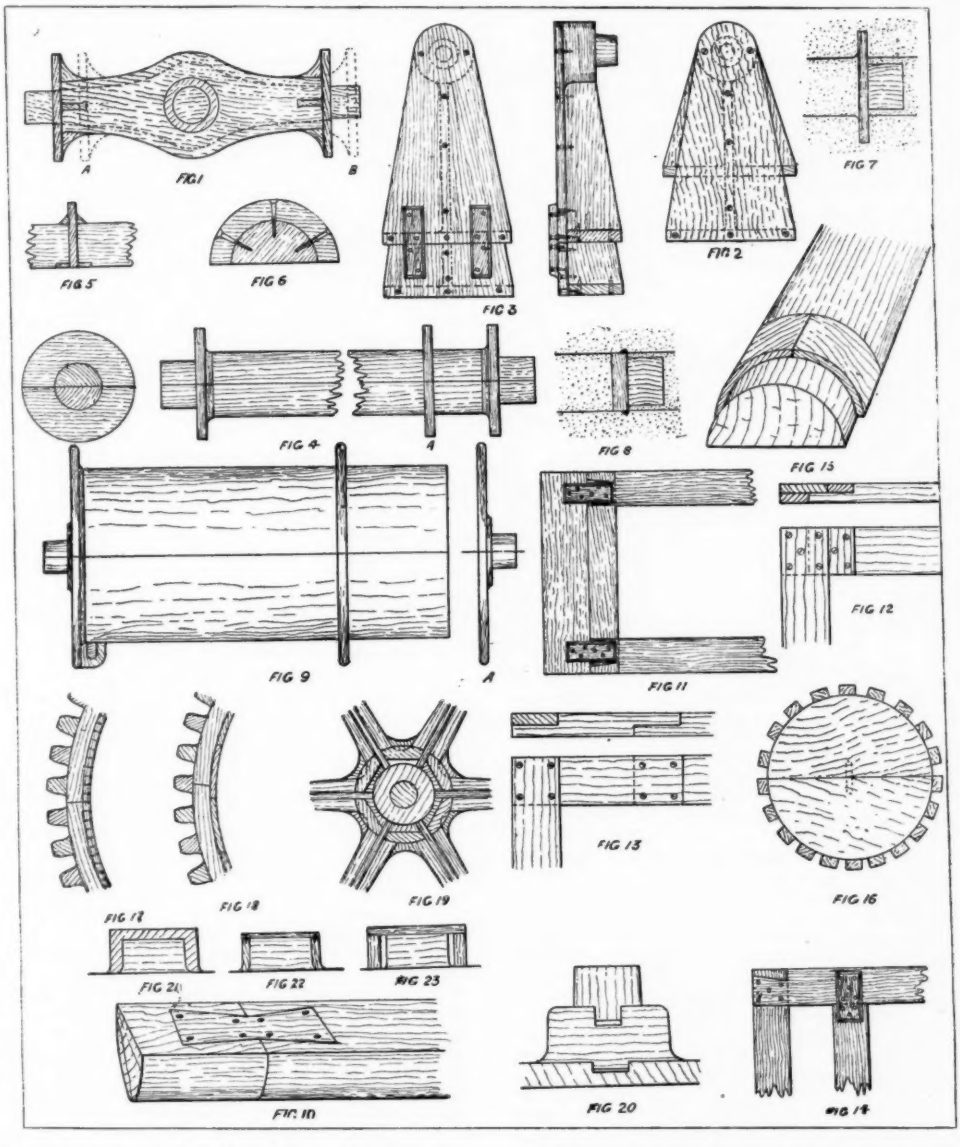
BY JOSEPH HORNER.

The significance of these alterations is appreciated by no one so much as by the foreman pattern maker, who is responsible for the accuracy of the patterns that are subjected to alterations. These are a fruitful source of error in several ways, errors in moulding, and at subsequent periods when the patterns are wanted as they were originally. Some are altered with no regard to consequences; the needs of the present only being considered. Others are treated in a more systematic and rational manner, both to avoid unnecessary cutting, and to leave some kind of permanent indication or record of the alterations which have been made. In some cases patterns are constructed in such a way as to facilitate alterations and modifications in outlines. Often this includes methods involving stopping off with no cutting.

Alterations might be very broadly classified under two heads—reducing and extending dimensions, each with or without modifications in outlines. The first kind is usually the more objectionable, not so much in itself as in the subsequent errors to which it might give rise. When such a pattern has to be used later, to enlarged dimensions, the original ones, patching has to be adopted, and this may often involve more work than the original cutting down did. Some kinds of additional fittings may cause the moulder trouble, while there are cases in which it is almost impracticable to enlarge patterns properly, as when they are flimsy or are cut into varied outlines.

Taking the cross girder pattern for a crane, Fig. 1, if this has to be shortened for a small order, to cut the pattern at each end is not adopted. The provision for a new end is outlined by the flange dotted at A. The mould is made good with a stopping-off piece of the same shape. Should this pattern have been cut back to A, with the necessity of extending it later to the original length, fresh pieces must be fitted with abutting joints, with screws inserted diagonally, or battens, to be stopped off. This is a weak and clumsy job. If a casting has to be lengthened, pieces are fitted at the extended length as at B, and the mould is stopped off. When the pattern is restored to its original form these pieces can be put back into the stores for future use. If apparently this is not satisfactory, it must be remembered that in almost every case it is better to stop-off than to cut patterns which have to be altered to their original dimensions. The interior of the casting in Fig. 1 is produced with a core, the outline of which is dotted and the prints for which are seen on the flanges.

A bracket can be shortened or lengthened at its foot end, or at the bossed end by stopping off, employing the methods shown in Fig. 1. The foot, Fig. 2, for shortening is fitted in the new position required, and the sand beyond the new foot is stopped off, using either a stopping-off piece or plain strips. To cut such a pattern and then extend it afterwards would be more expensive than to make two separate patterns. There is no great gain in stopping off in this plain example, but it is typical of more elaborate patterns. Fig. 3 shows a pattern bracket lengthened with a temporary



foot attached with battens. The edges of the web and rib in the original pattern must not be cut but stopped off.

Shortening by stopping off is regularly practised in column, pipe, and crane-drum work. These patterns are standard and are never altered, but make-up lengths of castings and jobbing orders are provided for with patterns and parts that are stored specially for alterations.

A pipe pattern, Fig. 4, has a loose flange A fitted on its body, or a socket or spigot similarly, either of which can be adjusted for length and screwed on. The body flange may be set with brackets, Fig. 5, to be stopped off, or be fastened with screws, Fig. 6. A stopping-off piece is inserted in the mould and forms the new print impression and stops off the redundant length of pipe. Fig. 7 illustrates the stopping-off of a pipe flange, and Fig. 8 that for a spigot end, the work having been completed. A crane-drum pattern is made in the first place as long as the longest casting likely to be required, and one flange is secured permanently to one end, Fig. 9. Different lengths are cast by screwing a body-flange on at the length required, and then stopping off the length beyond with a piece similar to A, Fig. 9.

Much pattern alteration is made in pipes, bends, tees. In most instances lengths are extended, and bends and tees attached with dovetails, as in Fig. 10. These are amply secure if well fitted, so that they pull the parts together. They vary, with pipe dimensions, from ¾ in. to 1¼ in. thick.

When plane pieces have to be lengthened or widened it is impossible to put screws in directly, as they can be through additions of an inch or two wide only. In such cases screws may have their heads sunk in deeply. Tightly fitting dowels, or short battens, Fig. 11, to be stopped off, may be used. These methods are suitable when boards have to be only moderately widened. Or a slight extension can be made as in Fig. 12. But when a framed pattern has to be extended so much that a single strip of board would not be wide enough, the frame can be extended as in Fig. 13, with half-lap joints, and then no stopping off is required. When a frame has to be shortened it need not be cut. If a strip is secured with battens at the shortened position, Fig. 14, the supplementary portion can be stopped off.

The enlargement of cylindrical parts may be continuous, Fig. 15, which occupies rather too much time, or it may be done with strips, Fig. 16, the interspaces to be filled with sand to make a continuous surface to be rammed against. Fig. 17 shows a strip, saw-kerfed, and bent round the interior of a wheel rim that requires strengthening, a method suitable for many cases where the strip is not too thick. Fig. 18 is the method of Fig. 15 applied to the inside of a rim.

When bosses have to be enlarged considerably diagonal blocks are fitted as in Fig. 19, held with screws put in diagonally. Bosses in general should be made interchangeable with a standard stud, as in Fig. 20, with core prints also having a standard size of stud. But this is only practicable when there are no arms or other attachments, like those in Fig. 19. When the original boss is a fixture and a permanent portion of the pattern, then larger bosses can be fitted in any of the three ways, Figs. 21 to 23, in addition to that shown in Fig. 19, the shells illustrated being cut to fit over arms or other parts. Fig. 21 is not a good method, because the shell boss is turned from a solid piece, and is therefore weak and liable to shrink. It is only suitable for a temporary fitting. In Fig. 22, sweeped pieces are fitted between arms, and are covered and retained in their positions with a plain disc over them. The same method is shown in Fig. 23, but the enlargement is greater.

Swedish Iron and Steel Industry.—According to a report issued by the Swedish Board of Trade on the activity of the iron and steel industry in that country during 1921, for every hundred men employed in mines working for export trade in 1913, only about 64 were employed on an average during 1921; the corresponding average percentage of men working in mines producing ore for home consumption during 1921 was only 45 per cent.; while, compared with 1913, the average percentage of men employed at blast furnaces was only 47 per cent. Compared with 1913, the average number of furnaces in blast during 1921 was only 22 per cent.

Simple Pattern-Numbering System.

"W. H. K.," writing in "Machinery," outlines a plan for numbering patterns which has been found to have many advantages. The pattern number is composed of three distinct elements, or groups, each representing one of the three essential points to be considered in the identification of a pattern, namely, the kind of machine of which it is a part, the type or size of the machine, and the detail number which identifies the casting on the machine.

The number is so constructed as to contain as few digits as possible, and, at the same time, conform to all the requirements of the system. To this end both letters and figures are made to follow one another in a compact sequence, without the use of dashes or spaces, the letters of the alphabet being used in the first and last groups, and the figures placed between, forming the intermediate group. In this way a distinction of the three parts of the number is effected.

The first group indicates the kind, or general classification, of machine. The middle group gives the detail number of the part, and the last group represents the size or type, or both size and type of machine, which in such a case can be indicated by one symbol that is composed of one or two letters.

As an example, suppose a concern is manufacturing a line of engines and pumps. The engines would be in one classification, represented by a letter, such as A, and the pumps in another, represented by B, these letters being first in the sequence of the number. Suppose the cylinder head of the engine has the detail number 10, and the base of the pump 13. The size of the engine in the example may be represented by the letter A, and that of the pump by H. Then the number A10A would designate the cylinder head of a size A engine, and B13H the base of a size H pump.

The plan for assigning the detail numbers should be independent of that for all other numbers. The detail numbers should be taken from a list, in rotation, as the parts are placed on the drawings; thus 10 need not stand for the cylinder head for any other size or type than the one cited, since that one size or type may be very simple, with few parts, while another type may be elaborate in design and require a large variety of details. The letter indicating the kind of machine or product should be assigned at the time it is determined to make or design such a product, and should be taken in its turn from a list. The letters for the size or type should be assigned in a similar way, and a separate list of letters for sizes belonging to each general class or kind should be kept distinct from all other classifications; thus A representing a size of engines should have no relation to A in sizes of pumps.

If the products of the concern should increase so as to cover many classes and types of machines it might be necessary to use two letters, either for classification or for size, and if the details of one machine run higher than ninety-nine in number it would be necessary to use three figures. The longest pattern number that is likely to occur under this system, however, would contain seven characters, such as AA107AB, but even such a case would be extremely rare. It is not likely that there would be over one letter in the end groups, or two figures in the middle, in most cases, making four altogether, which is as compact as it can usually be made.

There are some letters that are objectionable for use on patterns, when used in connection with figures, for the following reasons:—The letter O is identical with the zero of the numerals, and the letter I can hardly be distinguished from the figure one. The letter C could be made from O if a portion of the side should be washed out in the mould, and a portion of the letter Q could be washed out in a similar manner and made to look like O or C. If the lower portion of E were washed out it would look like F, and if A were shown indistinctly, and were read upside down, as is often the case on a casting, it might be taken for V. By eliminating all such objectionable letters, and having it known that the system does not contain them, there would be no chance of mistaking one for another.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

The Problem of Grey Iron Castings.

To the Editor of The Foundry Trade Journal.

Sir,—Many times over am I obliged to you for your thoughtfulness in giving me the opportunity to read Mr. Young's pithy Paper on "The Problems of Grey Iron Castings," in your esteemed Foundry Trade Journal of last December.

Not being familiar with iron-foundry conditions in England, perhaps I am unable to get the proper perspective on certain parts of the paper, but if the iron foundries in your country average up about as they do in this country, I should say that the Paper presents a canvas far too sombre. A great number of the so-called jobbing foundries in this country probably do run too freely by rule-of-thumb, but when it comes to castings requiring special mechanical properties, one is likely to find that these are made in foundries of quite another type, where the iron is under strict scientific control. The works with which I have had many years of experience deals extensively with castings for superheated steam, and, parallel with Mr. Young's experience, I have found that cast-iron for handling it must conform to fairly definite standards; making it do this has been accomplished by closely co-ordinating three important elements—laboratory analysis and testing, foundry melting, and machine-shop practice. These three must be synchronised, as it were, if the best results are to be obtained in the most practical way. In order to obtain the desired composition accurately and continuously there must exist the closest of ties between chemical laboratory and the foundry. The former must be so equipped as to be able to produce analyses during the progress of a heat in a minimum of time; this is a leaf taken from modern steel works practice. In the duplexing process the analysis of a charge is made between the time of its entering the electric furnace and the time of its leaving it, making it possible to correct the iron to the desired standards before being cast.

Somewhere else in the Paper I received the impression—perhaps wrongly—that Mr. Young does not find that pig-iron is sold and accepted or rejected by the purchaser upon the basis of the actual determined analyses of each lot. If this be the case it is surprising to me, as I have bought pig-iron for fifteen years upon no other basis, and I am by no means alone in the practice.

Mr. Young writes understandingly of graphite in cast iron. Undoubtedly size of castings and inferentially rate of cooling are the big factors in fixing the size of the flakes of graphite, but I wonder if some of the now undetermined gaseous constituents of the iron do not have some important bearing upon graphite precipitation. Indeed, I am inclined to believe that iron that has been duplexed, for instance, becomes sufficiently degasified in the electric furnace to exert a markedly retarding influence upon the headlong precipitation of massive graphite, and so produces a certain optimum fineness and dispersion of the graphite particles.

The case of sulphur Mr. Young rests entirely upon the proper balancing of sulphur and manganese. To me, unbalanced sulphur is inexcusable, and so general have I found this attitude among metallurgists that any discussion of the advantages and disadvantages of high and low sulphur in cast iron takes it for granted that manganese is present in quantity at least sufficient to prevent the formation of iron sulphide. As I see it, the sulphur problem is this: Is high-sulphur iron, with all the sulphur in the form of manganese sulphide, as good as low-sulphur iron under the same conditions, or what are the relative values of the two? Except in rare instances where high-sulphur is admittedly the proper iron, it seems that the defence of high-sulphur iron is a brave attempt to make the best of a bad bargain. As I have claimed before in the discussion of my paper of last autumn, before the Institute of British Foundrymen, high-sulphur, while capable of giving excellent test-bars, is much too prone to give disappointingly bad castings when the mechanical requirements of such castings are severe. However, I am willing to admit the possibility of there being some combination of favourable conditions under which manganese sulphide will be precipitated so as to work a minimum of harm and so yield results superior to low-sulphur iron that has been abused in the foundry. Under such conditions we are almost forced to give preference to iron on the basis of its foundry treatment. Who, however, will deny the distinct superiority of the combination of both good foundry practice and first-class irons? As for the sulphur problem, I believe it needs to be investigated scientifically and convincingly by some authoritative organisation of metallurgists and foundrymen, and I close these few remarks by expressing the hope that such research may be not far off.—Yours, etc.,

GEORGE K. ELLIOTT,
Chief Metallurgist.

The Lunkenheimer Co.,
Cincinnati, Ohio, U.S.A.

Belgian v. British Castings.

To the Editor of The Foundry Trade Journal.

Sir,—Some months ago the writer was in conversation with the principal of a large Belgian iron founder and elicited the statement that this foundry was supplying several British factories with castings. The association started presumably with the moulders' strike, but despite the fact that the strike has ended long since the gentleman in question had no reason to complain of the falling off in orders, except so far as was brought about by the general trade depression. In other words, the British founder lost a market during an unfortunate trade dispute, and despite the fact that the dispute ended in his favour he has not been able to compete with the foreigner in supplying castings to his own countrymen. There is no doubt that depreciated currency is a retarding factor, for the Belgian franc is still woefully cheap, but this gentleman was optimistic enough to declare that he would retain the market even when the exchanges became more normal. He based his conviction on the fact that (1) he could further reduce his price to meet the higher value of the franc, and (2) his product (on the testimony of his customers) was superior to that of the British founder, and gave the utmost satisfaction. There is no reason to doubt the good faith of the gentleman in question, so it may be taken for granted that, in the opinion of British engineers, the Belgian casting is superior to the British product. But is this a fact, or is that opinion influenced by the low price? The upheavals of the last few years have made comparisons with the past somewhat valueless, but it is significant that, prior to the war, when British castings were undoubtedly cheap, Belgian castings were preferred by many of the engineers of this country. Was this on account of price or of quality? And if in the past the Belgian could compete, why not in the future? It may be said that our foundry organisation has developed since the pre-war days, and that, with a general revival of trade, we shall be able to quote at a figure which will command attention. But what is the British founder doing to accelerate this trade revival, and how much has he contributed, by way of high prices and inefficient service, to the present depression? To the engineer, the casting is raw material, and if the price is high and the subsequent machinery costs heavy, then the manufactured product must perforce be expensive. So far as quality is concerned, the British casting, in the main, compares very well with the Belgian, for there are good and bad of each variety, but the difference between the Belgian and the British founder is that whilst the former will listen to a complaint, and either replace the goods or take steps to prevent a recurrence, the British founder often considers his customer too fastidious, and the sending of a formal apology is no indication that he will endeavour to do better in the future. The customer may have "a bee in his bonnet," but it should be humoured, nevertheless, if business association is to continue. The discussions which are constantly taking place at the various Institution Branches, as reported in The Foundry Trade Journal, are read with interest by the writer, and it is apparent that foundrymen are realising what is at stake and are determined to do all possible to get the industry into a more satisfactory state. Finally, we must regain our home markets together with a firm export trade.—Yours, etc.,

"Buyer."

Trade Talk.

C. H. Harrington & Company, engineers, etc., have established a branch in Sheffield at 38, Howard Street.

The Alfo Electrical Engineering Company have decided to close their branch at Telegraph Road, Heswall.

The Calderbank Steelworks of James Dunlop & Company, Limited, have been closed down for an indefinite period.

The steel foundry of Catton & Company, Limited, Black Bull Street, Hunslet, Leeds, was slightly damaged recently by fire.

Colonel O. C. Armstrong and others have presented a petition for the grant of a charter of incorporation to the Federation of British Industries.

A. C. & S. Green, Limited, iron, steel, and metal merchants, formerly of Coleridge Chambers, Corporation Street, Birmingham, have removed to Halesowen, near Birmingham.

Mr. J. N. Kilby read a paper to the Sheffield Association of Metallurgists and Metallurgical Chemists last week on "Basic Open-Hearth Steel and the Chemistry of the Furnace Slags."

Barimar, Limited, 10, Poland Street, Oxford Street, London, W.1, are now granting licences to operate their metallurgical process for recovering scrapped castings. Scored cylinders will still be treated by the company.

The firm of Sir Raylton Dixon & Company, shipbuilders, Middlesbrough, has gone into voluntary liquidation. Its Cleveland dockyard, which employed over a thousand men in normal times, may be permanently closed, a Middlesbrough message says.

Rothstein Izchakin & Company, New Stone Buildings, 61-62, Chancery Lane, W.C.1, inform us that in future the company will be known as the Engineering and Mercantile Company, Limited. This change is one of name only, and the business will be carried on by the same partners and on the same principles as before.

The business of Spicer & Company, Limited, Red Lion Street, Clerkenwell, E.C., has been taken over by the A. & A. Electrical Company, Limited, 13, Farringdon Road, London, E.C. The managing director of the former company, Mr. S. J. Levi, has been elected a director and manager of the A. & A. Electrical Company, Limited.

Another important ship-repairing contract has been lost by a Tyneside yard owing to the dispute on bonus stoppage. A large oil tank steamer was due for extensive repairs, but it transpired subsequently that it had been decided to divert the vessel to a Continental port. It is stated that the work on the ship would have provided employment for about 500 men for five weeks.

Over 200 members have signed a memorial to the Government asking them to give facilities for the passing of the Rating of Machinery Bill. The measure proposes amendment of the law relating to rating of premises containing machinery, the amendment to be in such a way as to assimilate the law on this subject in England and Wales to that prevailing north of the Tweed.

A demonstration of cutting and welding metals by the oxy-acetylene process was given recently to a numerous company at Messrs. Marple & Gillott's premises, St. James's Road, Gateshead. The plant used is manufactured by Oxhycarbon Company, London, whose sole Northern representatives are Messrs. A. C. Alexandra & Company, Pilgrim Street, Newcastle.

The ascertained price of West Coast mixed numbers of iron during March was £4 19s. 9d. per ton, a reduction of 2s. 4d. compared with the price for February. Furnacemen's wages drop 3 per cent., and are now 37 per cent. above standard. A year ago they were 275 per cent. above standard, so that there has been a fall in twelve months of 238 per cent. The scale percentage on bonus earnings is now 74½ per cent. in the Workington area and 69½ per cent. in the Furness district.

Under the quarterly ascertainment issued by the Cleveland Ironmasters' Association the wages of blast-furnacemen employed on the North-East Coast have been reduced by 1.50 per cent., which will bring the wages from 36 per cent. to 34.50 per cent. above the standard. The reduction, which takes effect from the 2nd inst., follows upon a drop in the ascertained price of No. 3 Cleveland pig-iron during the past quarter of 22s. 2.15d. per ton. The price for the quarter was 88s. 6.00d. per ton.

The oscilloscope, an invention for studying rapidly moving machinery, which has already proved of great value in the engineering world, has been perfected by Mr. A. J. H. Elverson. A piece of machinery, such as a crank-shaft, which may be turning 3,000 revolutions a minute, can be made actually to appear to be turning only 30 times a minute. Any engine or machine, in fact, while running at full speed, can be made to look as if it were only running at one-hundredth of the actual speed.

Among the many contracts awarded Daniel Adamson & Company, Limited, Engineering Works, Dukinfield, near Manchester, for Adamson-Rateau turbo-generating units for high pressure, mixed pressure, low pressure, draw-off and back pressure, the most recent is from Robert Heath & Low Moor, Limited, for a 1,000-kw. mixed pressure turbo-alternator set, with condensing plant of the jet type. Several schemes embodying Adamson-Rateau geared turbines for mill and factory drives are also under consideration.

The Blythswood Shipbuilding Company, Limited, of Scotstoun, have now launched their first vessel—the oil-tanker "Stonewall Jackson," of 10,700 tons capacity. The vessel is not only the first constructed by the company, but also the first to be built on the Montgomerie-Macmillan system of double-bottom construction. The yard is managed by Mr. H M. Macmillan, one of the founders of the firm, who was formerly shipyard director to the Fairfield Shipbuilding and Engineering Company, Limited, of Govan.

The Court of Appeal, it is stated, will not be troubled further with the Baldwins share case. The response to the proposals for settlement circulated among the dissentient shareholders by their Committee has been satisfactory, says the "Financial Times." The Dissentient Shareholders' Committee, according to this authority, submitted alternative offers in the shape of a stated amount of damages or the purchase of shares held, viz., £1 12s. 6d. per share as damages, or £2 7s. 6d. per share as purchase price. The majority of the shareholders concerned with the action have agreed to accept the damages.

The Brightside Foundry & Engineering Company, Limited, have been invited by the London County Council to recommence their contract for the heating, ventilating and hot-water installation at the Epsom Asylum. This work was suspended during the war, and in the present state of trade depression the decision to restart comes at a very opportune moment. The contract is for a complete installation, consisting of four 30 ft. x 8 ft. Lancashire boilers working at 120 lbs. pressure, a fuel economiser, 4 calorifiers, with boiler feed pumps, circulating pumps, etc., complete system of steam heating, fan system of ventilation and accelerated installation of hot-water service. There are in all 36 buildings, and the contract price in 1914 amounted to £21,760. All the calorifiers, expansion joints, and most of the special parts will be made in the company's works at Sheffield.

The Siam State Railways recently invited tenders for 20 bogie trucks for carrying timber. The 15 lowest offers received were all from Belgian firms, with the La Brugeoise et Nicaise et Deleuve firm at the bottom with 14,361 fcs. f.o.b. and 17,972 fcs. c.i.f. The French Compagnie Générale des Aciérs, of Marly, quoted 21,913 fcs. and 28,653 fcs. respectively; the tender of Messrs. Craven, of Sheffield, was 21,824 fcs. and 27,472 fcs.; that of the American Car Company 28,550 fcs. c.i.f.; the Linke-Hofmann Works, of Breslau, quoted 24,648 fcs. f.o.b. and 27,729 fcs. c.i.f.; the Dutch Rotterdam Machinery Works 25,306 fcs. f.o.b. The Van der Zypen firm's tender was among those between 26,000 and 28,000 fcs. The Augsburg-Nuremberg Machinery Works quoted 29,783 fcs.; the Italian Ernesto Breda Milan and Officine di Savigliano quoted 30,810 fcs. and 35,945 fcs. respectively f.o.b. The rearguard included several German firms with offers ranging from 35,000 to 40,000 fcs. f.o.b., one English firm (Charles Robert & Company, of Wakefield) and a Danish firm (Carl Holtermann, of Copenhagen).

Palmers Shipbuilding & Iron Company, Limited, of Hebburn-on-Tyne, have accepted the tender of Sir John Jackson, Limited, Jarrow and London, for the construction of a dry dock at Swansea in connection with the ship repairing and engineering works they are establishing at that port. The dry dock is the first of two parallel docks which Palmers Company intend to construct on the south side of the King's Dock, close to the large entrance lock. The dry dock will be entered from the King's Dock, the water level of which is practically constant. Thus ships will be able to enter and leave the docks at any state of tide. The first dock is to have an entrance of 75 ft. clear width, and is to be 560 ft. long internally. The dock gates will be of steel, opened and closed by means of hydraulic rams, and an installation of powerful electrically-driven centrifugal pumps is to be installed for emptying the dock. The installation will also serve the second dock when the latter is built. The buildings for the repair yard will be erected on the south and east sides of the dry dock, and the yard will have a considerable frontage to the King's Dock.

Company News.

Globe Supplies (Electrical), Limited.—Capital £500 Director: F. Bruce.

Mitchell's Emery Wheel Company, Limited.—Registered office: 1, Cross Street, Openshaw, Manchester.

Burndert, Limited.—Capital £20,000 in £1 shares. Wireless engineers. Registered office: 391, Strand, W.C.

Jowitt Engineering Company, Limited.—Capital £750 in 1s. shares. Directors: J. E. Hackford and R. F Power.

Seck Machinery Company, Limited.—Capital £5,000 in £1 shares (2,500 7 per cent. cumulative preferred ordinary).

A. Peckston, Limited.—Capital £1,000. Engineers. Directors: A. Peckston and A. W. Foster. Registered office: Middlesbrough.

Abraham Greenhalgh & Son, Limited. — Capital £2,500 in £1 shares. Engineers. Directors: H. Greenhalgh, F. Jackson, and T. Greenhalgh.

Weaver & Mason, Limited.—Capital £5,000 in £1 shares. Weldless steel tube manufacturers. Registered office: Beacon Works, Darlaston Road, Wednesbury.

J. Manson Ramsay & Son, Limited.—Capital £5,000 in £1 shares. Engineers, shipbreakers and iron and steel merchants. Registered office: 62, Robertson Street, Glasgow.

Ellerby Foundry, Limited.—Capital £6,000 in £1 shares (1,000 preference and 5,000 ordinary). Directors: W. H. Day and B. C. Dyson. Registered office: Ellerby Lane, Leeds.

G. Tunnicliffe & Company, Limited.—Capital £5,000 in £1 shares (2,000 A. ordinary, 1,000 B. ordinary, and 2,000 ordinary). Engineers, etc. Permanent directors: G. Tunnicliffe and H. E. Bailey.

G. H. Morris, Limited.—Capital £1,000 in £1 shares. Engineers. Directors: G. H. Morris, E. Duckworth, and S. H. Thomas. Secretary: H. Morris. Registered office: Badger Street Works, Bury, Lancs.

F. T. Everard & Sons, Limited.—Capital £50,000 in £1 shares. Ship repairers, etc. Directors: F. T., F. W., W. J., A. M., and Alice E. Everard. Registered office: The Wharf, High Street, Greenhithe.

Ashfield & Salt, Limited.—Capital £2,000 in £1 shares. Bolt and nut manufacturers. Directors: W. Ashfield, F. J. Salt, and J. Parsons. Registered office: Vicarage Road, Blackheath, near Birmingham.

Henry Summers & Sons, Limited.—Capital £3,000 in £1 shares (1,300 8 per cent. cumulative preference and 1,700 ordinary). Engineers. Directors: H. Summers, W. D. Summers, and E. Summers. Registered office: 1a, Essian Street, Stepney, E.1.

Gazette.

MESSRS. W. J. ROSE and G. F. Rose, brass founders, 24, Great Wilson Street, Leeds, trading under the style of Rose & Parkin, have dissolved partnership.

A RECEIVING ORDER has been made against Sir Edgar Rees Jones, M.P., who was at one time a director of Charles Hatton & Company, Limited, and was associated with the Welsh Plate and Sheet Manufacturers' Association.

IN the Companies (Winding-up) Court, Mr. Justice Lawrence has made orders for the compulsory liquidation of the Powerite Steam Jointing Company, Limited, the Super Engineering Company, Limited, and the Swift Electrical, Limited.

THE PARTNERSHIP heretofore subsisting between Messrs. R. Winterbottom, W. M. Winterbottom and R. B. Cocks, welding engineers, Toll Bar Street, Middle Hillgate, Stockport, under the style of the Stockport Welding Company, has been dissolved.

THE PARTNERSHIP heretofore subsisting between Messrs. T. Greaves, J. H. Smith and W. H. Darbourne, engineers, pattern makers, etc., Quarry Lane, Mansfield, trading under the style of the Engineering Woodworking Company, has been dissolved.

Iron and Steel Output in March.

The National Federation of Iron and Steel Manufacturers report that the production of pig-iron in March amounted to 389,800 tons, compared with 300,100 tons in February and 386,000 tons in March, 1921. Of the March output of pig-iron, 149,300 tons were hematite, 113,000 tons basic, 86,000 tons foundry, and 20,100 tons forge.

The production of steel ingots and castings in March amounted to 549,400 tons, a figure higher than in any previous month since December, 1920, when it was 746,600 tons.

The average monthly output in 1920 was 669,500 tons of pig-iron and 755,600 tons of steel ingots and castings. The corresponding figures for 1921 were 217,600 tons and 302,200 tons respectively.

Personal.

THE LATE MR. J. PETTIGREW, chairman of the London Engineering Company, Limited, left £41,636 (net £33,064).

MR. W. E. MILLER, secretary of the Arizona Copper Company, Limited, for 33 years, has resigned, and has been succeeded by Mr. W. Rintoul, *pro tem.*

THE LATE MR. Z. W. ONIONS, for some years general manager of the Wolverhampton Steel & Iron Company, Limited, left estate of the gross value of £1,862.

MR. A. W. WILKES has succeeded Mr. T. I. Leeke as representative in South Wales of John Shaw & Sons (Wolverhampton), Limited, hardware merchants, &c.

MR. A. BALFOUR, of Sheffield, has sailed for the United States, to watch the interests of Sheffield during the passage of the Fordney Tariff Bill through the American Senate.

LIEUTENANT-COLONEL C. F. HITCHINS, D.S.O., M.I.Mech.E., who recently resigned the appointment of general manager to Agricultural and General Engineers, Limited, has joined Sir W. G. Armstrong, Whitworth & Company, Limited.

MR. JOSEPH F. W. BINNS, J.P., chairman and managing director of Frederic Selby & Company, patent axle-tree manufacturers, of Birmingham, has been appointed vice-chairman of the Staffordshire Education Committee.

MR. O. NETTLEFOLD has been re-elected president of the National Hardware Association. Other re-elections include:—Acting vice-president, Mr. J. G. Bower; vice-presidents, Mr. J. Scott Balfour, Mr. F. Burris, Mr. R. Gibson, Mr. J. Keeves, Mr. E. Le Bas, and Mr. F. A. B. Lord.

THE LATE SIR GEORGE J. CARTER, managing director of Cammell, Laird & Company, Limited, president of the Shipbuilding Employers' Federation during the war, formerly a director of Sir W. G. Armstrong, Whitworth & Company, Limited, and a director of the Coventry Ordnance Works, Limited, left £20,755.

Deaths.

MR. J. BRIERLEY, metal broker, of Latchford, died recently.

MR. G. BARKER, who formerly carried on business for many years at the Horton Ironfoundry, near Slough, died recently.

MR. D. THORBURN, of the Fullwood Foundry Company, Limited, Mossend, Lanarkshire, died recently in his fifty-second year.

MR. FRANK CROWTHER, head of the firm of Henry Crowther & Sons (Cleckheaton), Limited, pulley makers, died on March 22.

MR. F. FIRTH, of Frank Firth & Company, Limited, machinery brokers, Cleckheaton, died recently in his sixty-first year.

MR. THOMAS GILL, managing director of the Spencer Wire Company, Limited, Cleckheaton, Yorks, died recently in his fifty-seventh year.

MR. RACSTER EVERITT, a gentleman widely known in ferro-alloy and mineral circles, has died at the age of 71 years. Mr. Everitt was the founder and chairman of Everitt & Company, Limited. Chapel Street, Liverpool, and was the pioneer in the Russian manganese industry, in which country he had travelled extensively. He was also a director of the Indian Manganese Company, Limited, and largely interested in many other trade directions.

New Micheville Rolling Mills.—American-built structural mills are being installed by the Société Anonyme des Aciéries de Micheville, in France. One unit consists of a 44-in. reversing blooming mill, a 36-in. reversing roughing mill, two stands of 28-in. three-high rolls and one stand of 28-in. two-high rolls. This unit will be used as a combination rail and structural mill. The second unit is a light structural mill, and consists of one stand of 24-in. three-high rolls, two stands of 20-in. three-high rolls, and two stands of 20-in. two-high rolls. The 44-in. reversing blooming mill has rolls 37 in. in diameter, with body 100 in. long. It is equipped with modern mill tables and manipulator. With the exception of the passes in the rolls, it is an exact duplicate of the 44-in. American blooming mill built for Homécourt. The 36-in. roughing mill has a new feature. Large collars are necessary on the bottom rolls to permit rolling blanks for structural beams. This ordinarily means an exceptionally wide window or a removable cap on the housings. These collars are frequently 48 to 50 in. in diameter. To overcome these difficulties, the engineers designed a new roll-carrying device for the mill. The bottom roll is mounted in a cradle which can be moved by a hydraulic cylinder. The mill has a screwdown, as it will, at times, be operated as a billet mill.

IRON AND STEEL MARKETS.

Pig-iron.

A customary experience in holiday times, the week's pig-iron markets have been virtually suspended, and though a few deliveries have been despatched, the business transacted has only been of a routine character. It is, however, satisfactory to report that the tone of markets generally has shown an improvement of late, and, notwithstanding current labour troubles, some of the foundries remain at work, although it must be admitted that pig-iron consumption is just now restricted within very narrow limits. In South Staffordshire sellers are adhering firmly to recent quotations, although attractive business may still secure concessions. The demand in the Black Country applies principally to foundry pig, very little of the forge quality being required at present. The Cleveland market, as usual, will be partially closed during the current week, but, prior to the holidays, had experienced a revival of active demand, extending alike to the home and export trade, and substantial deliveries have been despatched. The shipments to Germany have been especially heavy, of which a fair proportion has been Cleveland iron. The announcement of a reduction of 1½ per cent. in Cleveland blast-furnacemen's wages, and of 13.9 per cent. in the percentages payable on the standard rates to the Cleveland miners, marks a further step in the lowering of the costs of production. This does not, however, represent more than a very small saving on a ton of pig-iron, but is nevertheless welcome as an indication of a tendency in the right direction. The following are current official minimum quotations:—No. 1, 95s.; No. 3, G.M.B., 90s.; No. 4 foundry, 87s. 6d.; No. 4 forge, 82s. 6d. No. 1 is so scarce as to be all but unobtainable, and forge is also far from plentiful, and is being quoted at round about 2s. 6d above the minimum. Mottled and white are negotiable at about 80s. per ton. The foreign demand for East Coast hematite is still quite active. Business may not be quite so brisk, but still fair quantities of iron are being sold, and there has been no further weakening of the price, which remains at 97s. per ton for East Coast mixed numbers, and 98s. for No. 1. Workington reports a steady business in West Coast hematite, with price unchanged at 98s. 6d. for Bessemer mixed numbers at works.

Finished Iron.

The interruption of the holidays can have little effect upon business in the finished iron industries, many of the departments being at present either closed down or working much below capacity output, so that a further stoppage can hardly make any marked difference in the position. At Birmingham last week the market was affected to some extent by the recent reduction in wages, and buyers of finished iron were insisting that the movement justified a revision of prices to lower levels. Subsequently it was reported that crown iron had been bought at £11, while the commoner qualities were subject to keen competition, especially fencing and nut and bolt iron, in which makers in other districts are said to be pursuing a cutting policy. The reduction in marked bars does not seem to have made much difference as yet, but it is anticipated that more orders will be given out now that the price is so much more favourable to consumers. There is nothing more encouraging to say concerning gas strip. Some important makers are still off the market on the ground that the price obtainable is unremunerative, and that they can find more profitable occupation in other lines. Those who are at work find it difficult to compete against steel strip. In the West of Scotland a few of the foundries manufacturing the heavy class of pipes or vertical castings have got a fair number of orders on their books, but unfortunately this class of work is in the minority, and those that go in for light castings or heavy marine castings and similar work are, with perhaps a few exceptions, finding great difficulty in keeping their cupolas working.

Steel.

Although confidence in an early return to active conditions in the steel industry has, to some extent, been checked by the engineers' lock-out and the trouble in the shipyards, there seems evident a fairly strong undercurrent of optimism, suggesting more hopes for the future, based on an increased volume of overseas inquiry and the improved exports shown in last month's Board of Trade returns. In the semi-products department, for example, works are receiving considerably more specifications for sheet and tinplate bars, and the price is maintained at £7 7s. 6d. It is understood that efforts are being made to extend the area over which the official price operates, as for many months now the makers have been quoting 10s. or more per ton less than the official basis for delivery outside the recognised area, and consequently there has been a considerable amount of dissatisfaction among consumers. The recent announcement of several important railway orders from an allied country mentioned in last week's journal still requires confirmation. On the other hand, a further announcement is now being made to the effect that an enormous sum of £100 million is to be expended upon the restoration of Indian railways. If this be a fact, there should follow a flood of orders for rolling stock, permanent-way materials and general railway requirements sufficient to make its effect felt throughout the length and breadth of this country.

Scrap.

The position in the scrap metal trade continues unsatisfactory, many deliveries under current contracts having been suspended owing to the effect of the labour troubles. On the North-East Coast quotations generally are unchanged at about last week's levels as follows:—Heavy steel scrap, 60s. to 62s. 6d. per ton; heavy wrought-iron bushelling scrap, 62s. 6d.; ditto, piling scrap, 62s. 6d.; ditto, heavy forge, 67s. 6d. to 70s.; heavy cast-iron machinery scrap, 82s. 6d. to 87s. 6d.; ditto, ordinary quality, 77s. 6d. to 80s.; steel turnings and cast-iron borings, 42s. 6d. All delivered works.

Tinplates.

The improvement previously reported in the tinplate market is well maintained, shipments for last week showing a satisfactory increase, while there is a steady inquiry all round. Quotations are fairly firm as follows:—I C 14 by 20, 112 sheets, 108 lbs., 19s. 3d. to 19s. 9d. per box; I C 28 by 20, 112 sheets, 216 lbs., 38s. 6d. to 40s. per box, net cash, f.o.b. Wales. Wasters.—C W 14 by 20, 108 lbs., 17s. 6d. to 17s. 9d. per box; C W 28 by 20, 216 lbs., 35s. to 35s. 3d. per box; C W 14 by 13¾, 170 lbs., 18s. to 18s. 3d. per box; C W 20 by 10, 156 lbs., 23s. to 23s. 3d. per box, all net, f.o.b. Wales.

Metals.

Copper.—The improvement indicated in last week's report of the standard copper market has been fairly well maintained, fluctuations in values being confined within narrow compass, with near dates attracting consistent attention. Better advices have come also from America, and there are hopes that the situation in the United States will tend to improve further. Dealings for April ranged from £58 17s. 6d. to £58 12s. 6d.; July, £59 2s. 6d.; three months, £59 2s. 6d. to £59 10s.; and cash, £58 15s. to £58 10s. Refined sorts remained steady and unchanged. Closing prices.—Cash: Wednesday, £58 2s. 6d.; Thursday, £58 15s.; Friday, ——; Monday, ——; Tuesday, £59. Three months: Wednesday, £59 10s.; Thursday, £59 2s. 6d.; Friday, ——; Monday, ——; Tuesday, £59 12s. 6d.

Tin.—Adverse Eastern advices have had a weakening effect upon the past week's standard tin market, a large amount of three-months' metal changing hands at depreciated values. Selling pressure has been persistent, while the holiday spirit is also probably accountable for the absence of a strong buying movement. April dates were done at £149 to £148 5s. up to £149 5s., closing at £148 15s.; May, £148 15s. to £149 5s.; June, £149 15s.; July, £149 10s.; three months, £150 10s. to £150; and cash at £148 15s. English ingots closed rather higher at £153. Straits for shipment from the East to New York, April-May, sold at £152 10s. and £152 5s.; and May-June at £152 10s., all c.i.f. A premium of 25s. over standard was paid for Mount Bischoff. Shipments from the Straits during the first week of April totalled 1,250 tons. Closing prices.—Cash: Wednesday, £148 5s.; Thursday, £144 2s. 6d.; Friday, ——; Monday, ——; Tuesday, £152 15s. Three months: Wednesday, £149 15s.; Thursday, £145 15s.; Friday, ——; Monday, ——; Tuesday, £154.

Spelter.—A stronger tendency may be noted in the market for this metal, due in some measure to an improvement in the galvanising trade and partly to the restriction on Continental supplies. Closing prices.—Ordinary brands: Wednesday, £26 10s.; Thursday, £26 7s. 6d.; Friday, ——; Monday, ——; Tuesday, £26 15s.

Lead.—The market for soft foreign pig remains practically unchanged, with prices firmly maintained. English qualities continue steady. English closing prices: Wednesday, £24; Thursday, £23; Friday, ——; Monday, ——; Tuesday, £24.